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(54) **SURGICAL STAPLING APPARATUS INCLUDING SENSING MECHANISM**

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USPC 227/19, 175.1, 175.2, 176.1, 180.1; 606/139, 151, 153, 219
See application file for complete search history.

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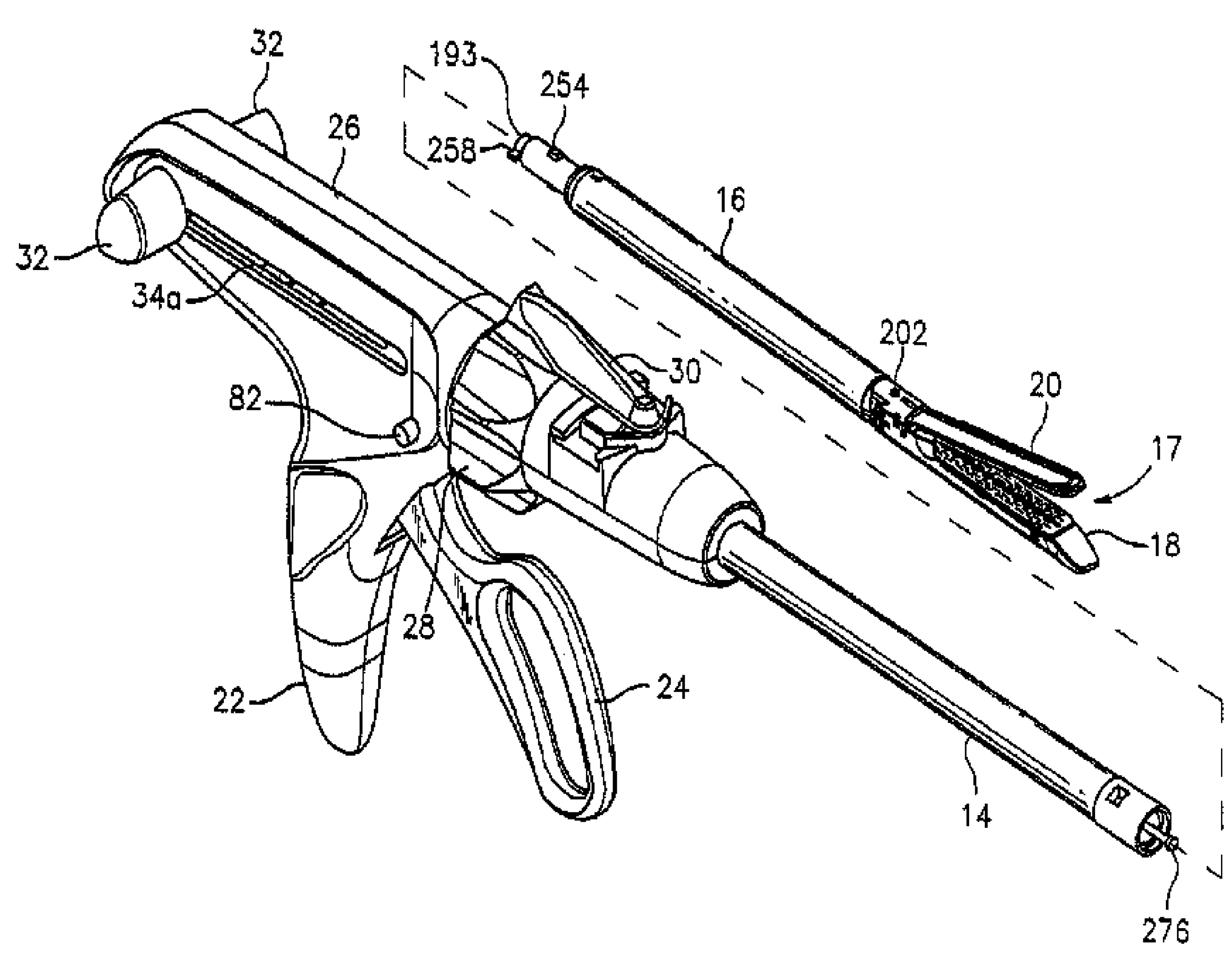
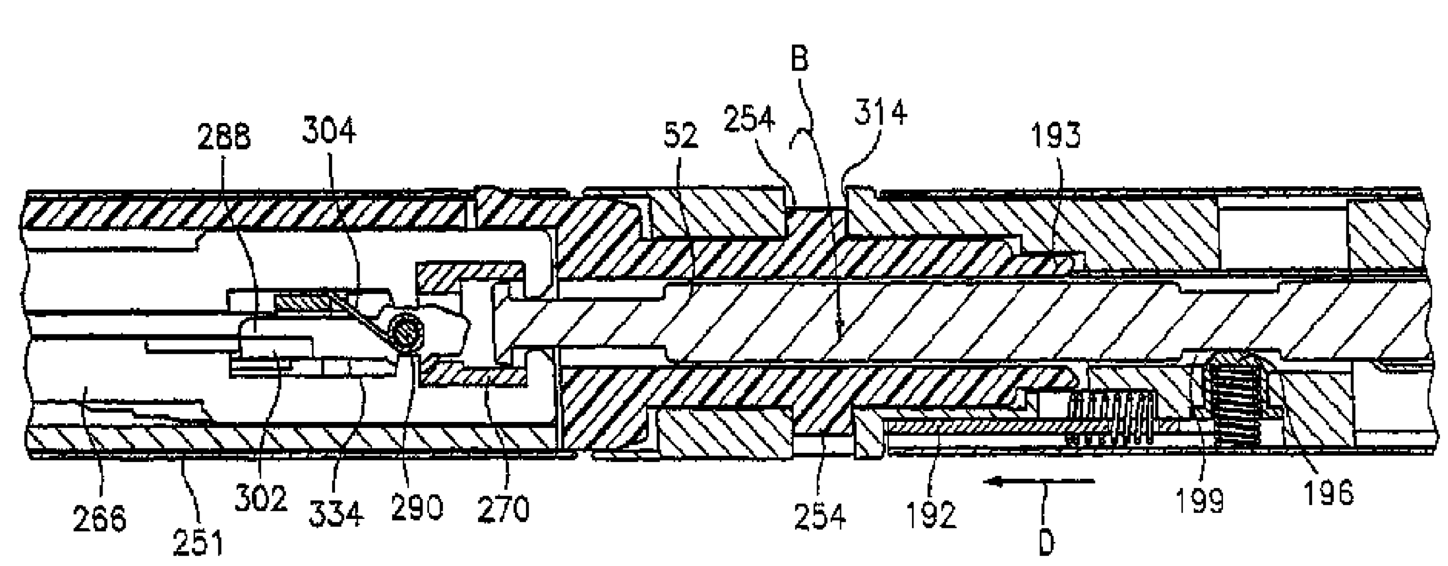
(57) **ABSTRACT**

A surgical stapling device particularly suited for endoscopic procedures is described. The device includes a handle assembly and an elongated body extending distally from the handle assembly. The distal end of the elongated body is adapted to engage a disposable loading unit. A control rod having a proximal end operatively connected to the handle assembly includes a distal end extending through the elongated body. A control rod locking member is provided to prevent movement of the control rod until the disposable loading unit is fully secured to the elongated body of the stapling device.

10 Claims, 39 Drawing Sheets





Related U.S. Application Data

of application No. 10/983,288, filed on Nov. 5, 2004, now Pat. No. 6,953,139, which is a continuation of application No. 10/700,250, filed on Nov. 3, 2003, now abandoned, which is a continuation of application No. 10/014,004, filed on Dec. 10, 2001, now Pat. No. 6,669,073, which is a continuation of application No. 09/680,093, filed on Oct. 5, 2000, now Pat. No. 6,330,965, which is a division of application No. 09/561,567, filed on Apr. 28, 2000, now Pat. No. 6,241,139, which is a division of application No. 09/166,378, filed on Oct. 5, 1998, now Pat. No. 6,079,606, which is a division of application No. 08/935,980, filed on Sep. 23, 1997, now Pat. No. 5,865,361.

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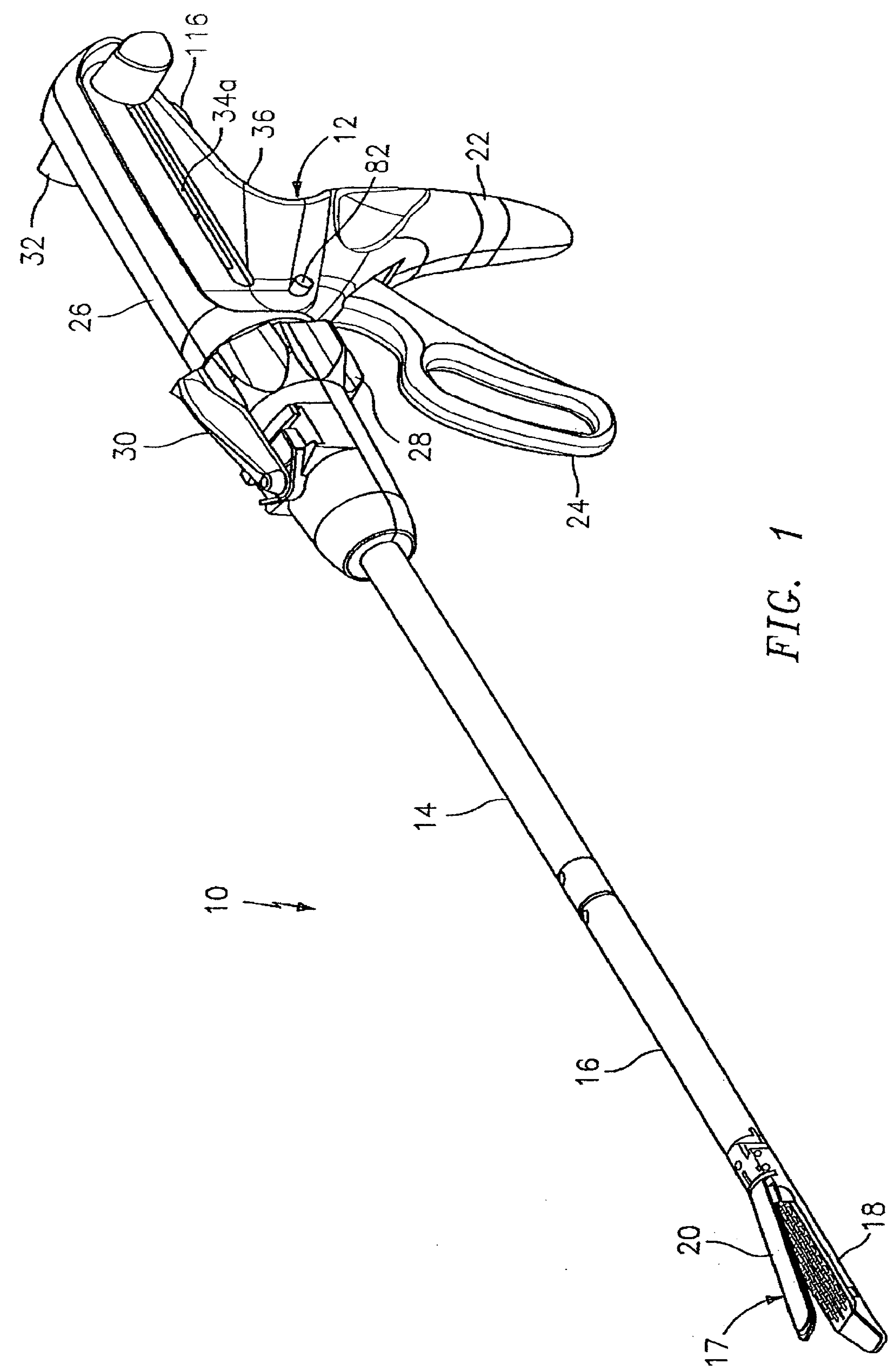

FIG. 1

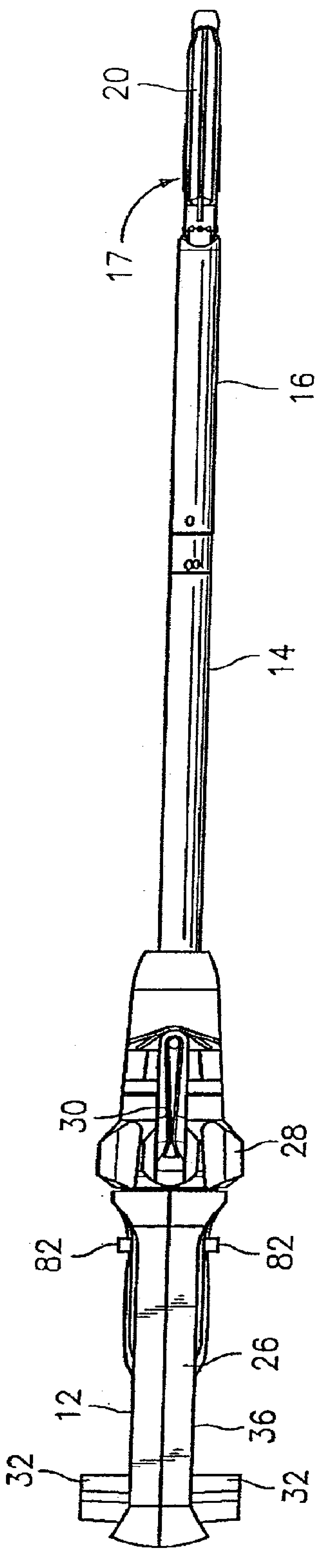
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FIG. 2

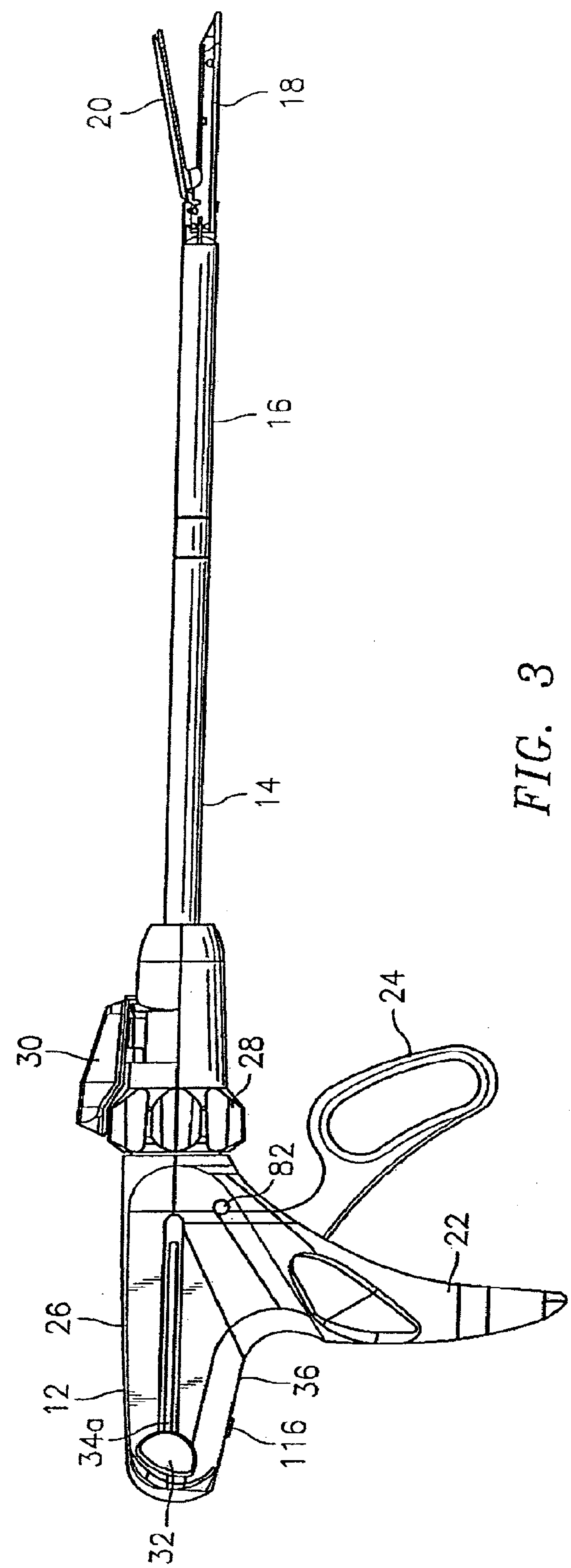
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FIG. 3

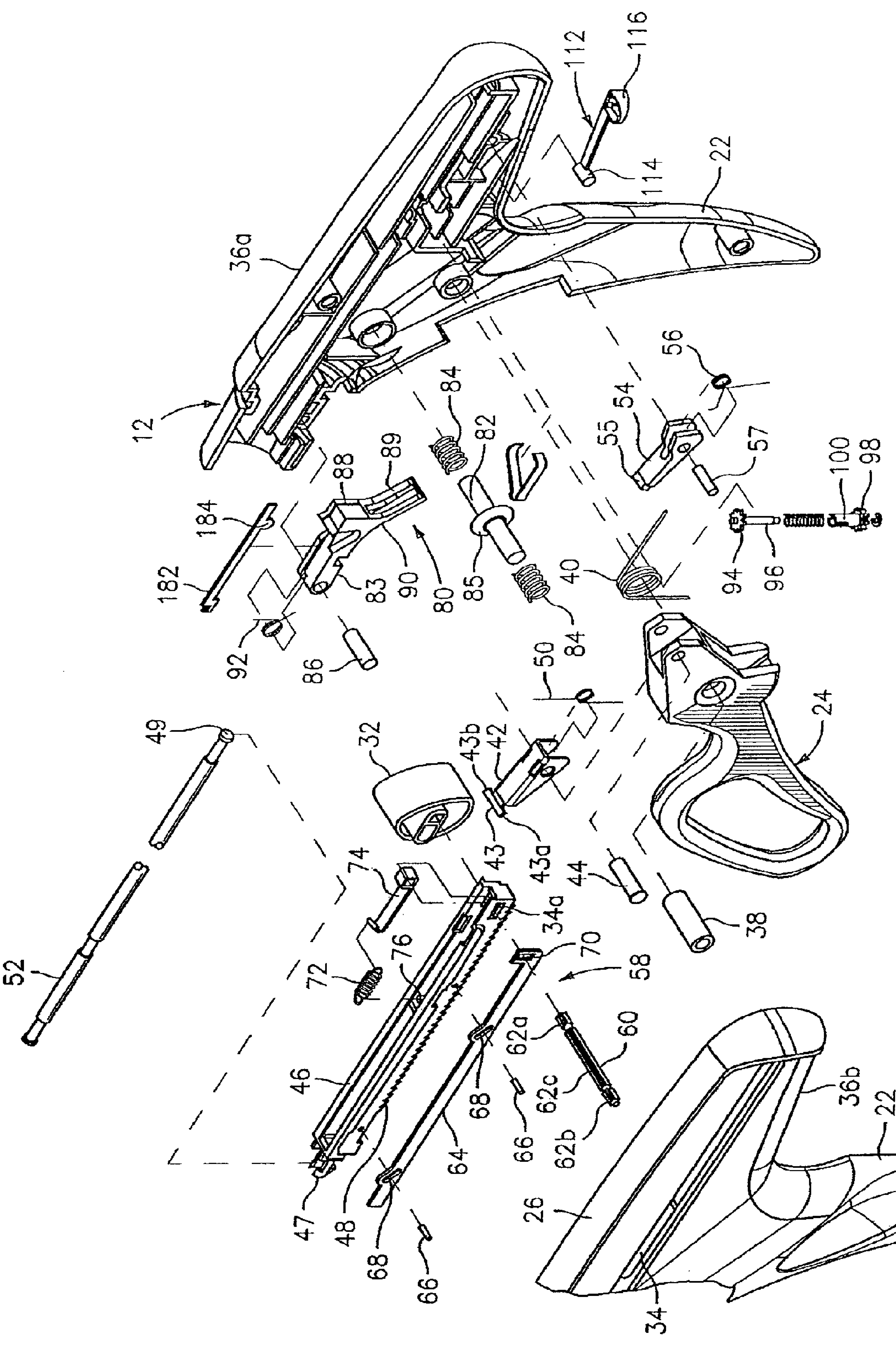

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FIG. 4

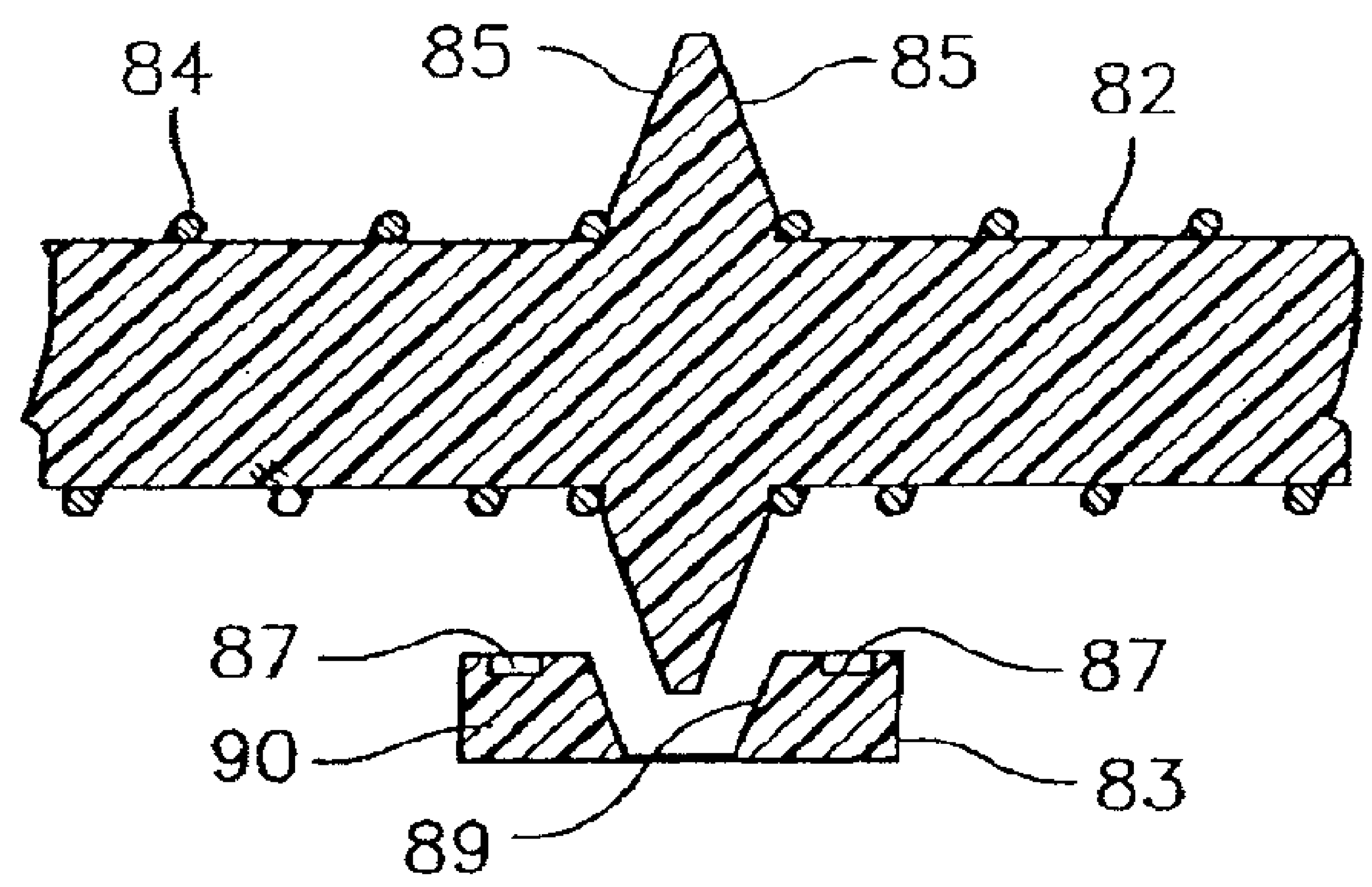

FIG. 5

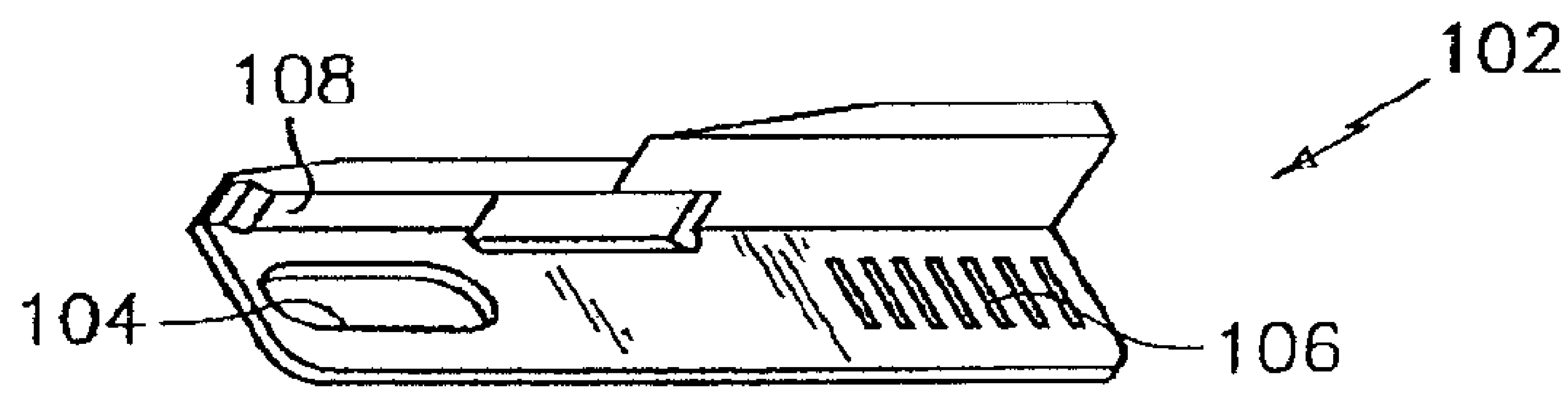

FIG. 6

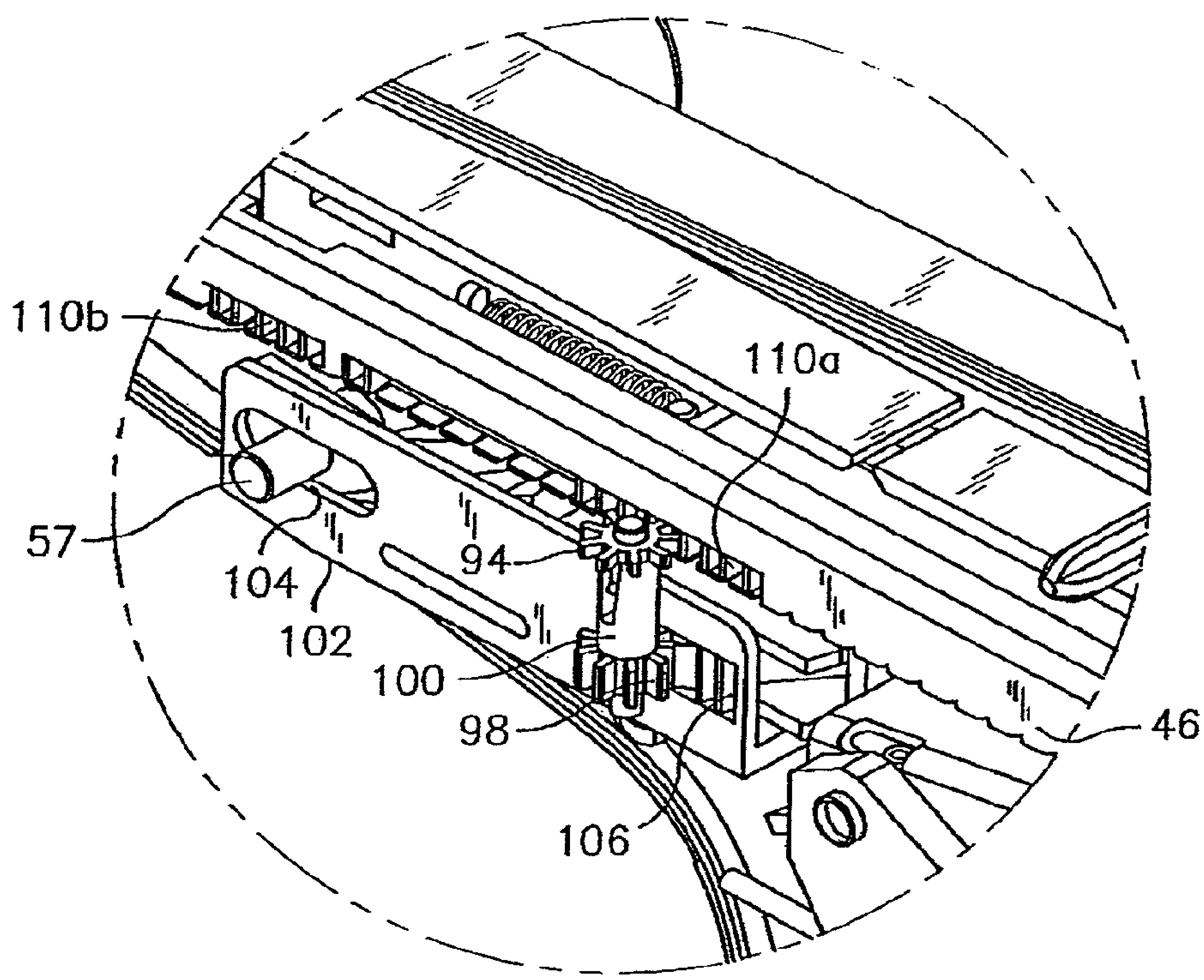

FIG. 7

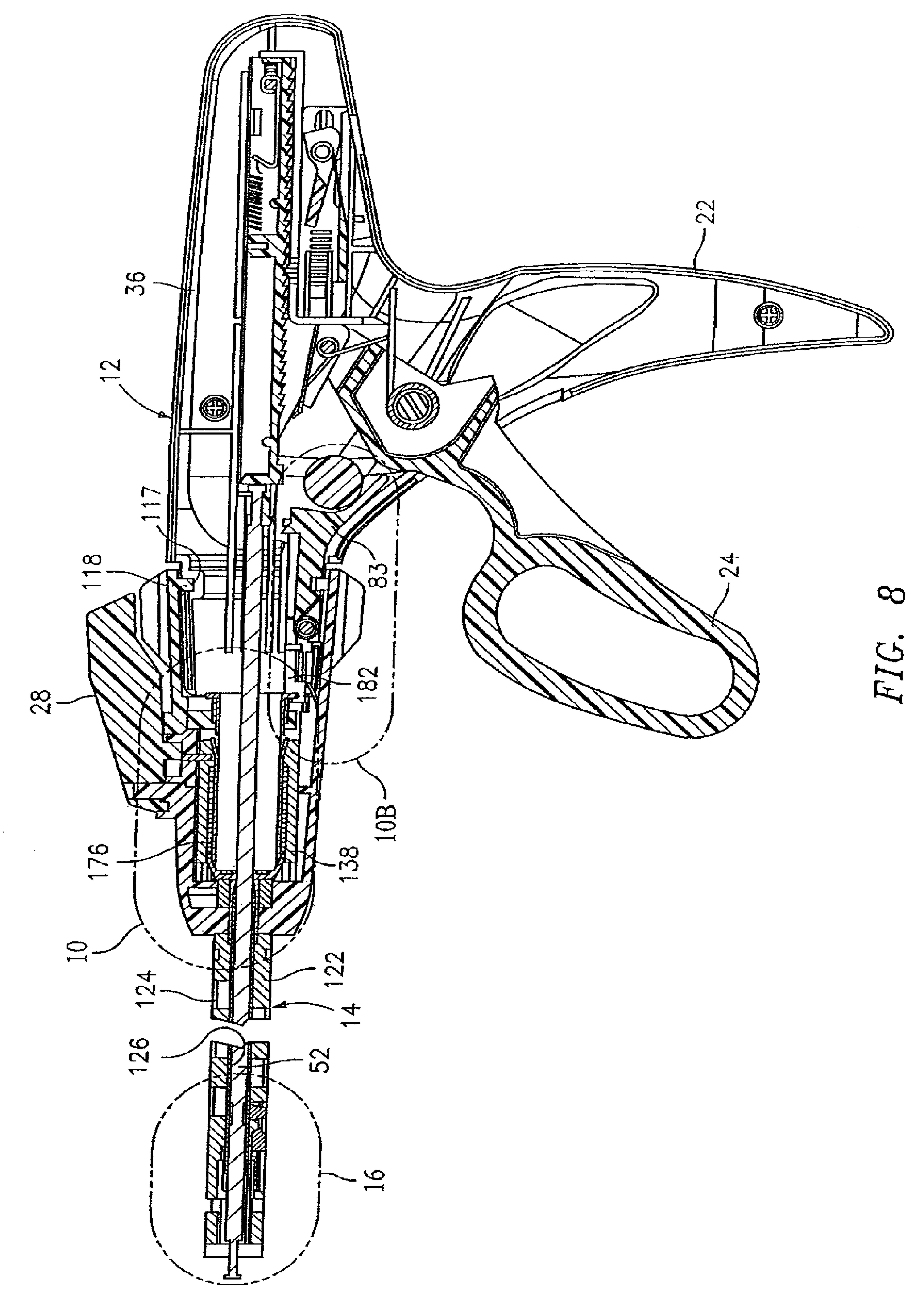

FIG. 8

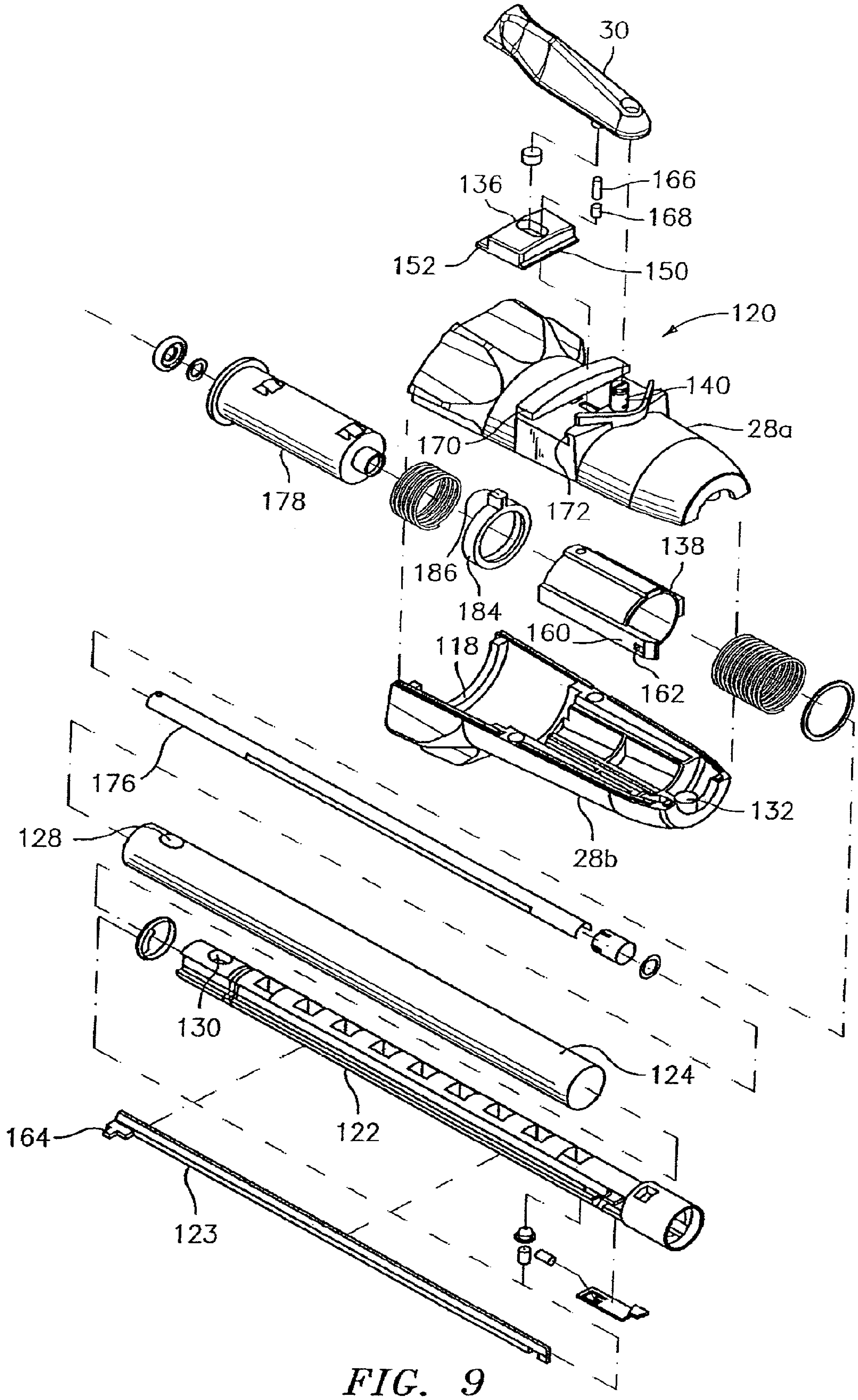
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FIG. 9

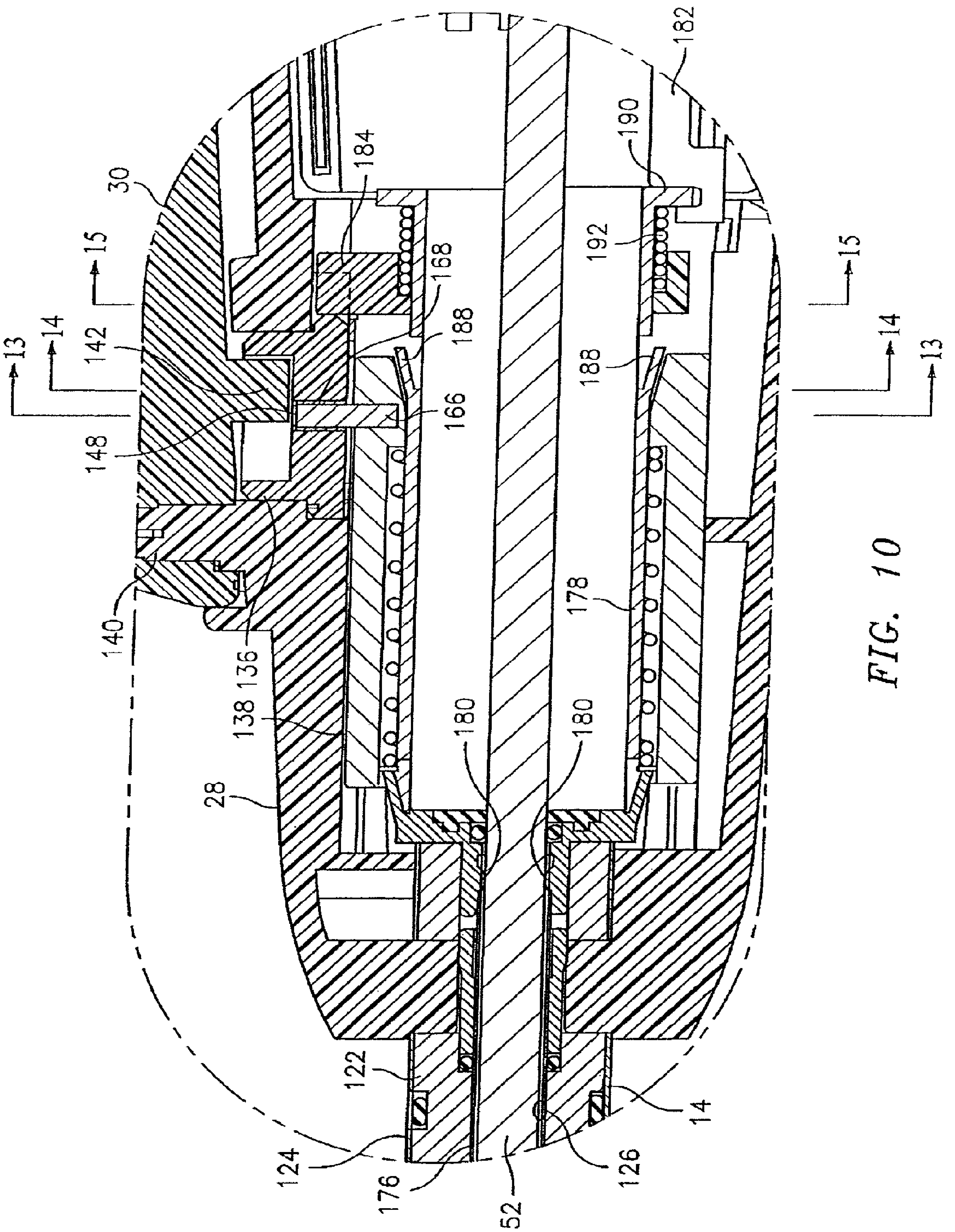
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FIG. 10

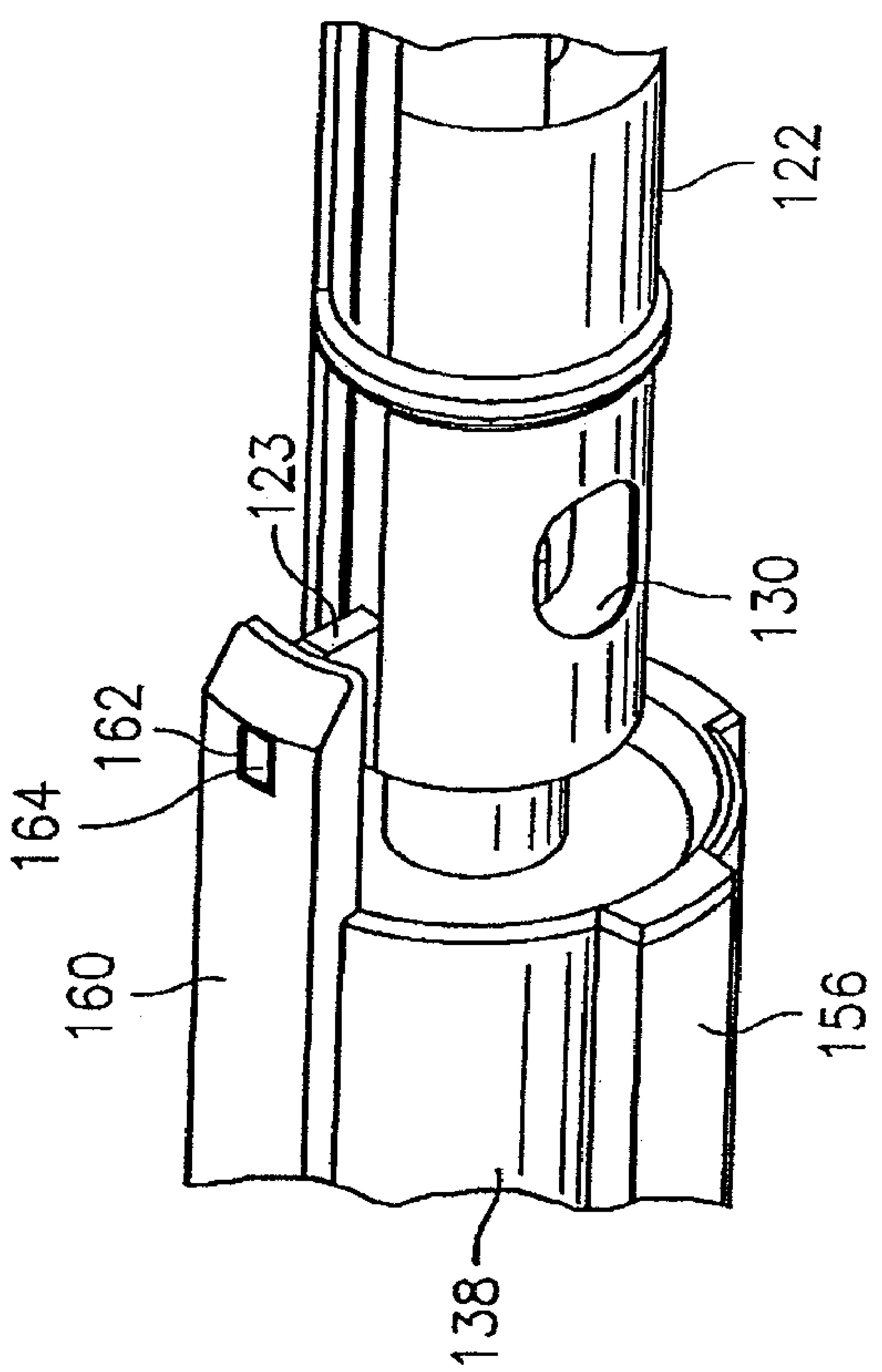

FIG. 10A

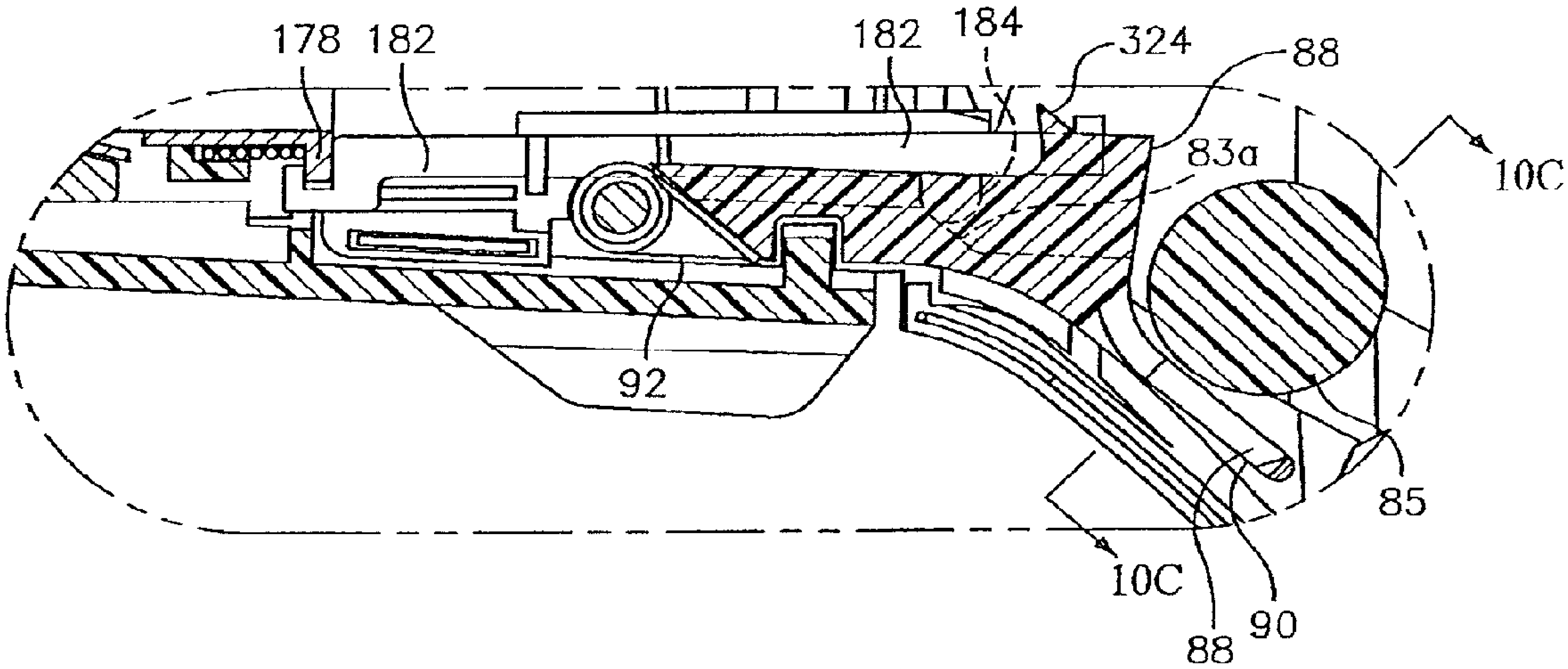

FIG. 10B

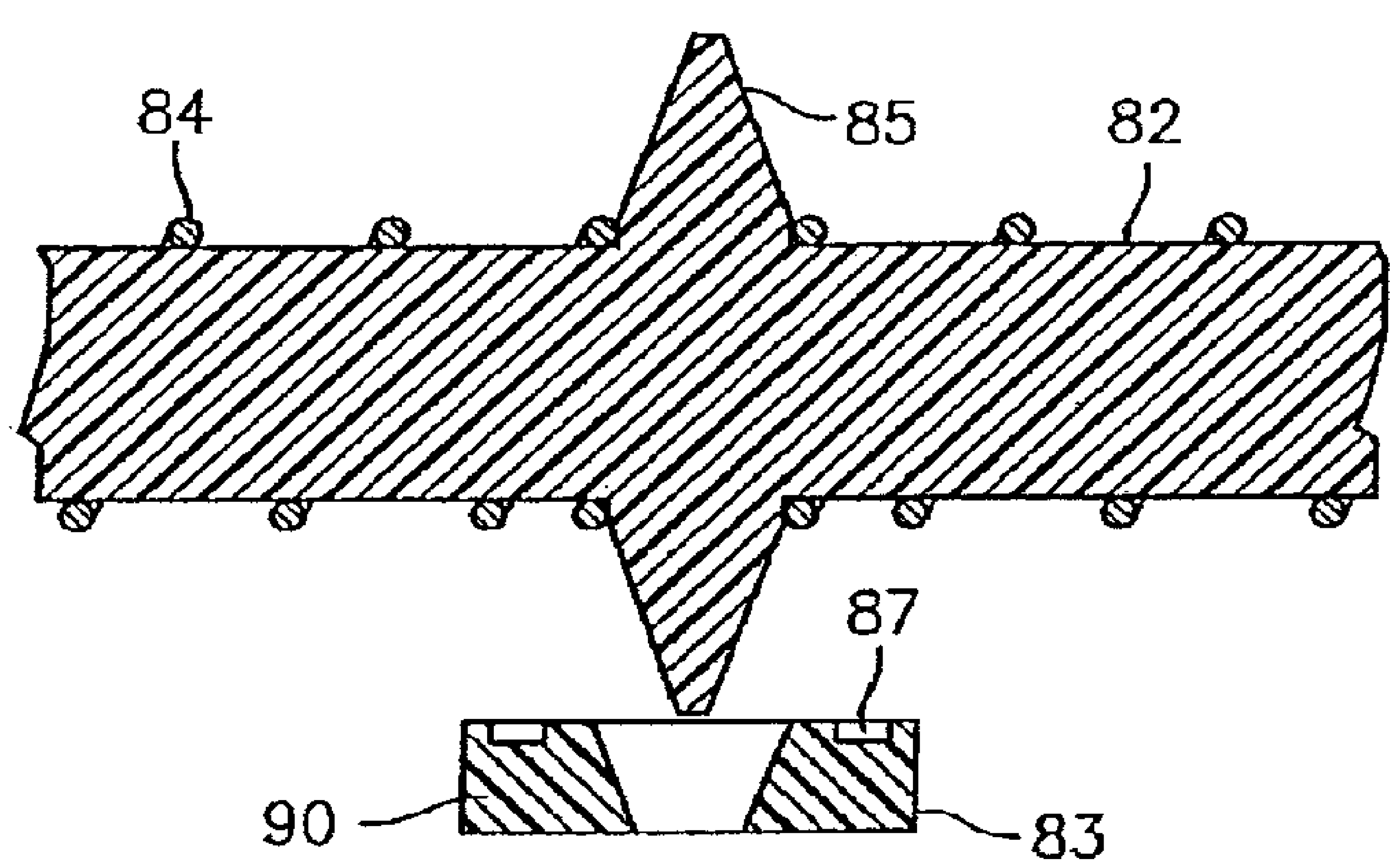

FIG. 10C

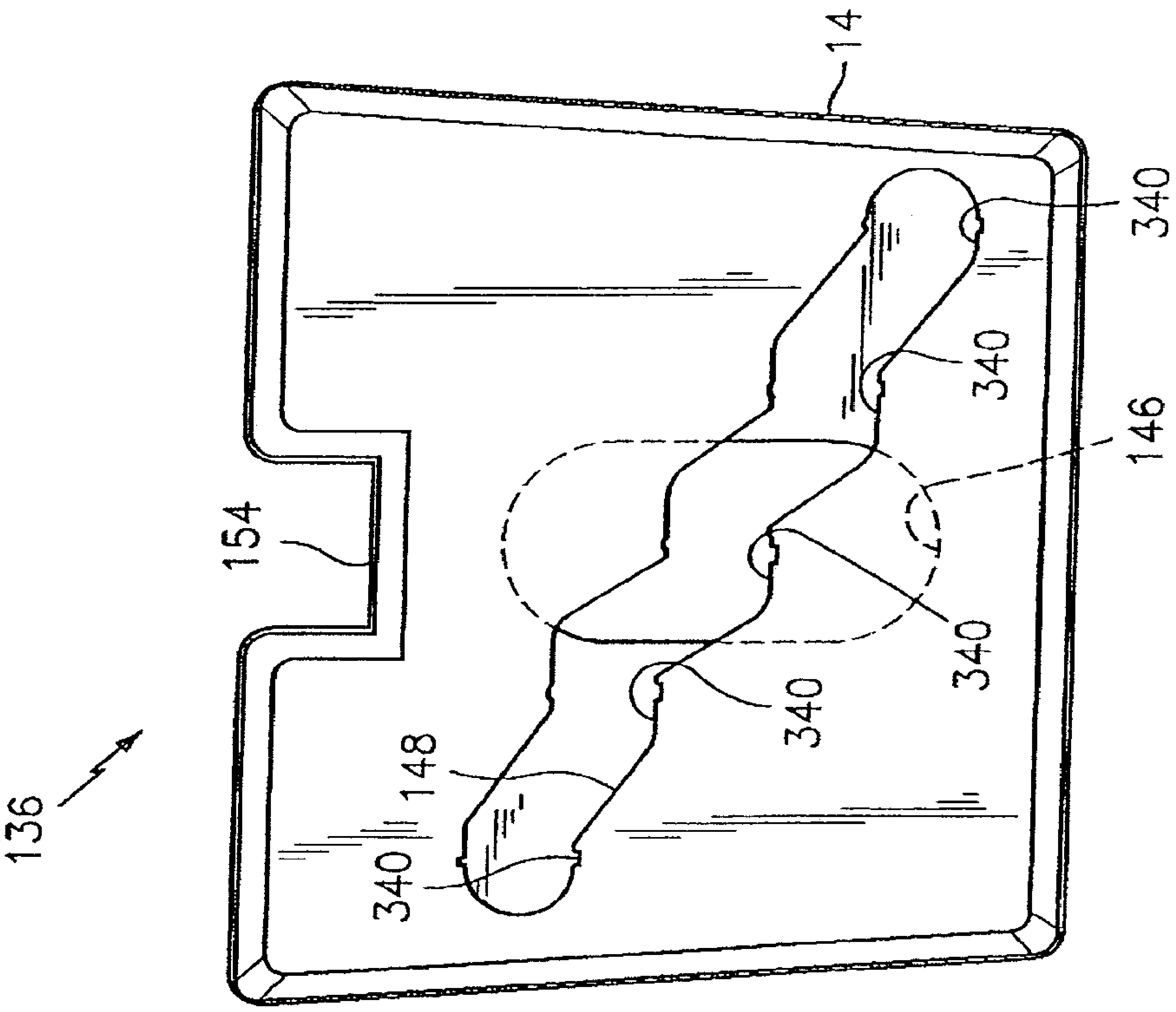
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FIG. 12

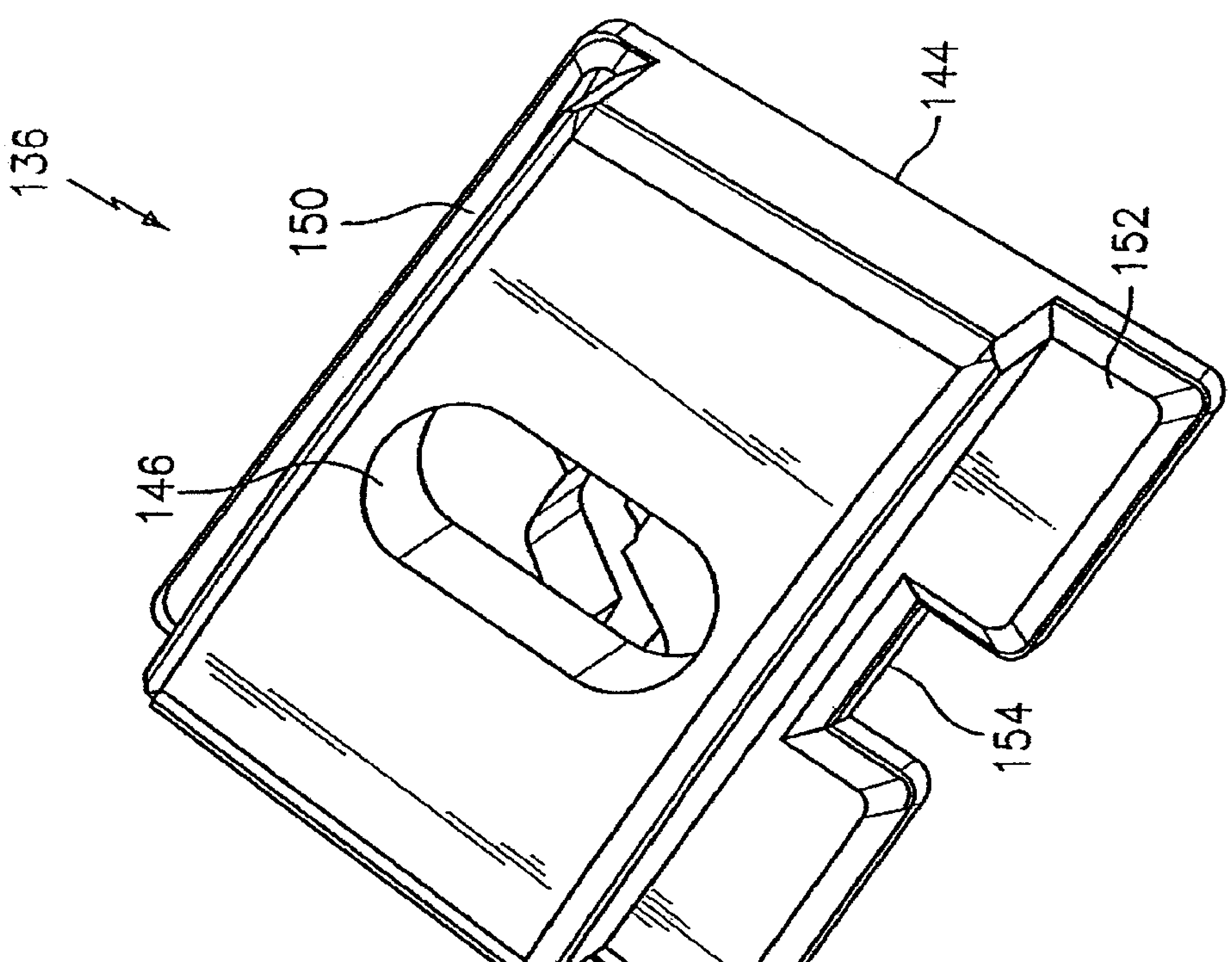
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FIG. 11

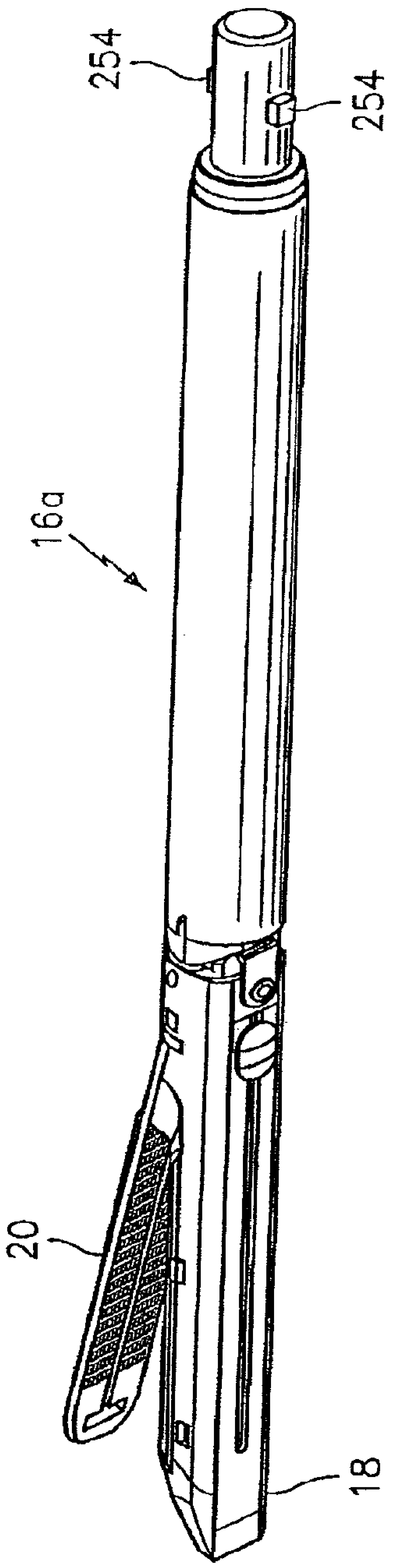

FIG. 12A

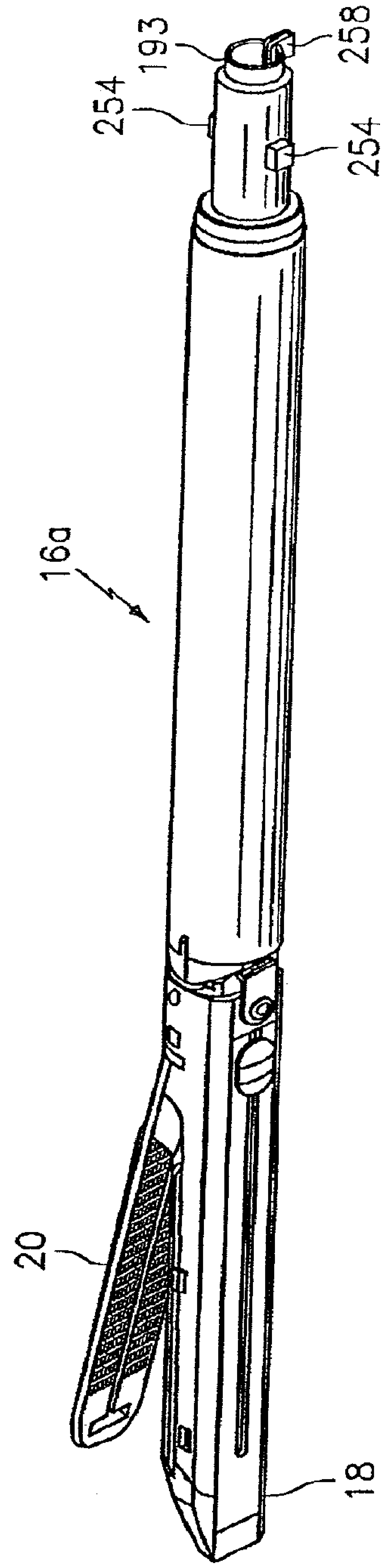

FIG. 12B

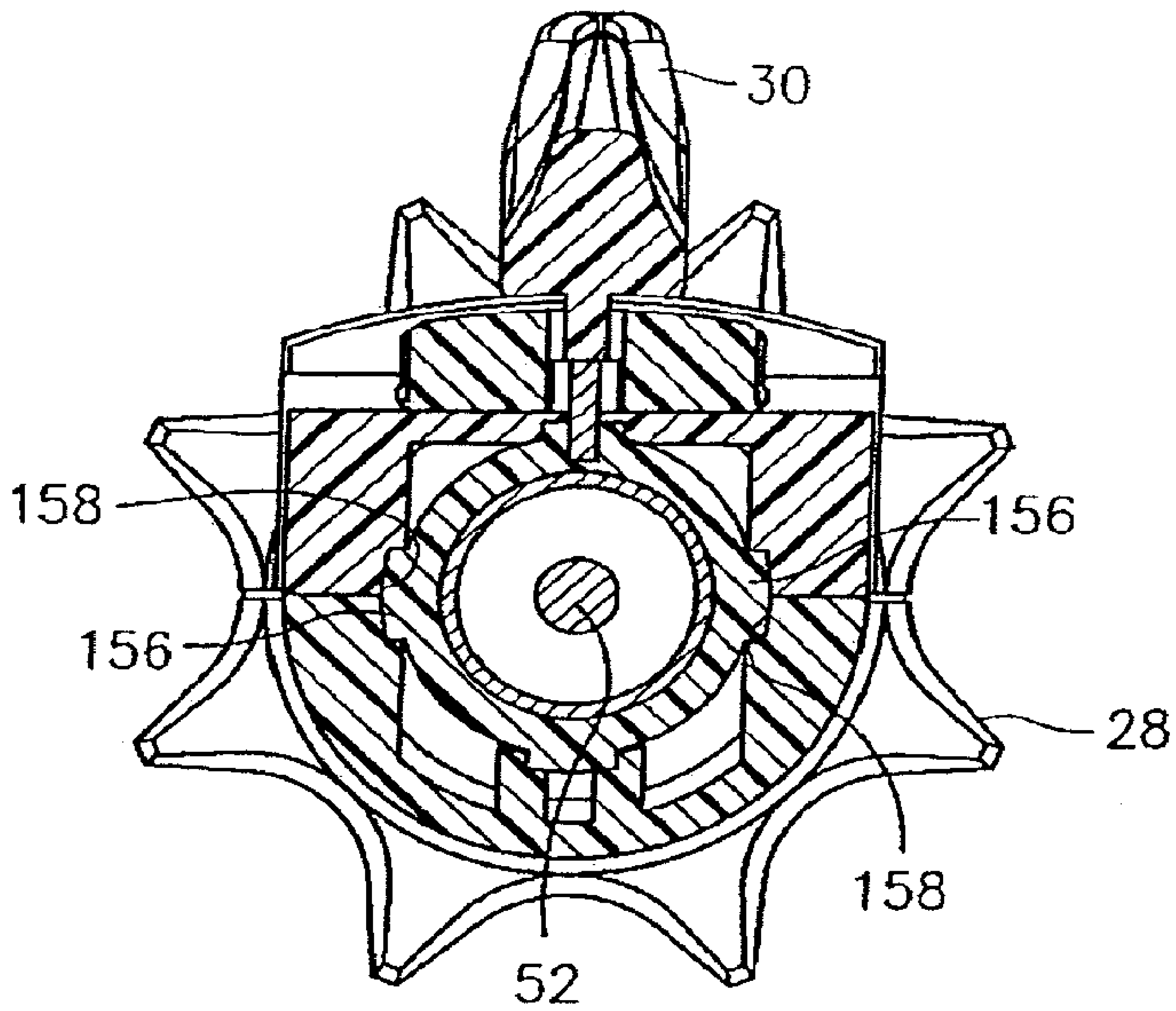

FIG. 13

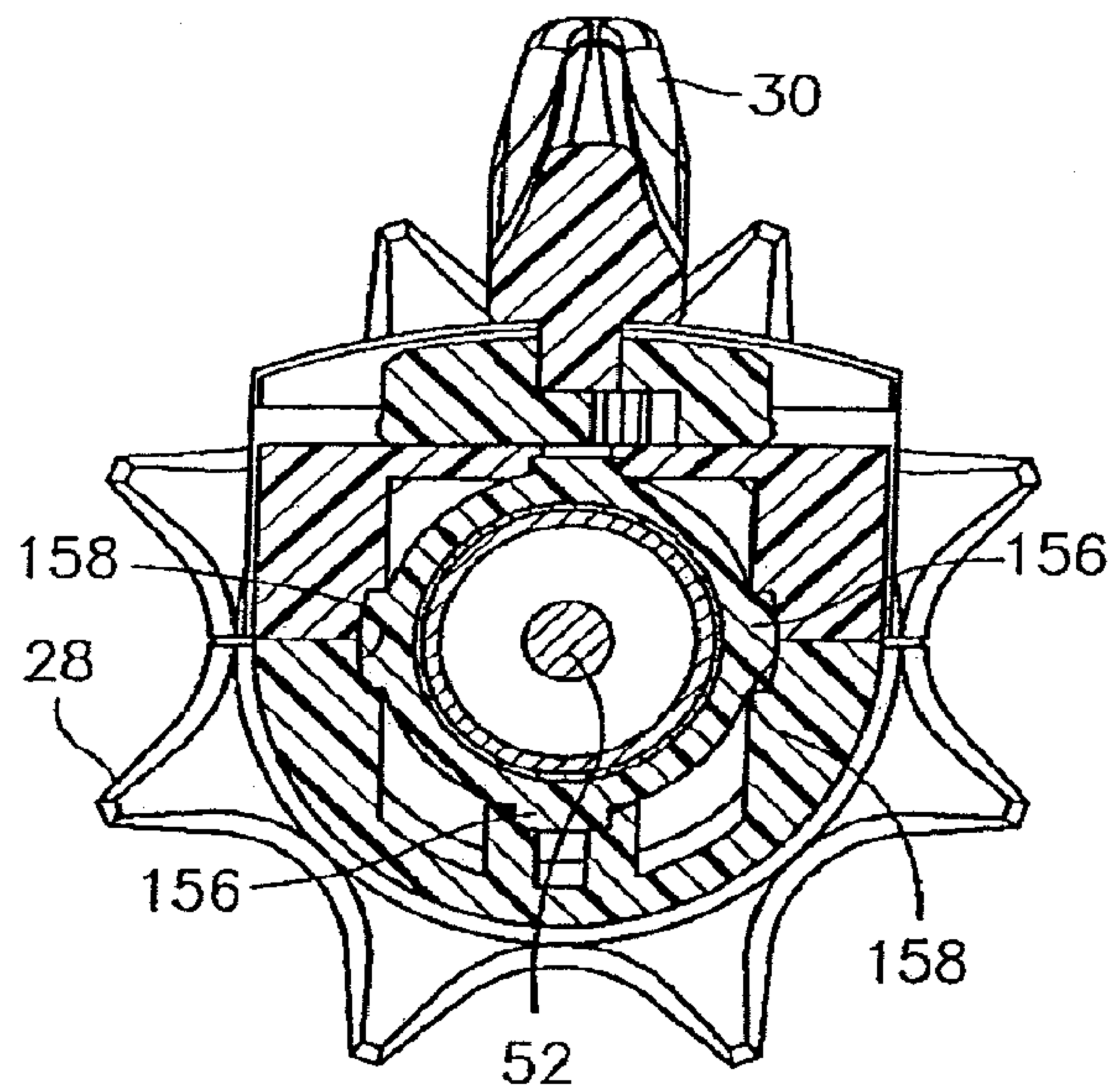

FIG. 14

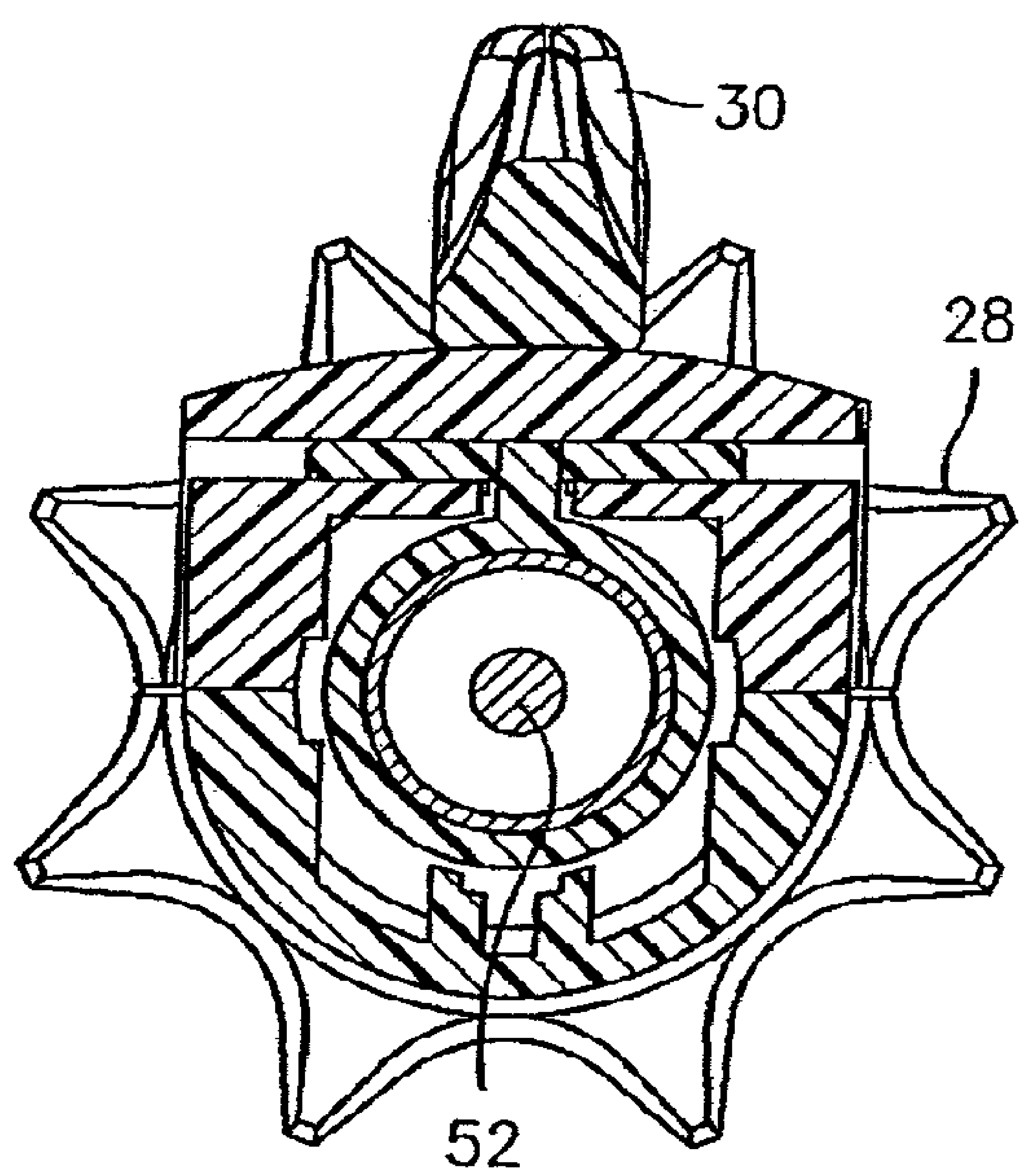

FIG. 15

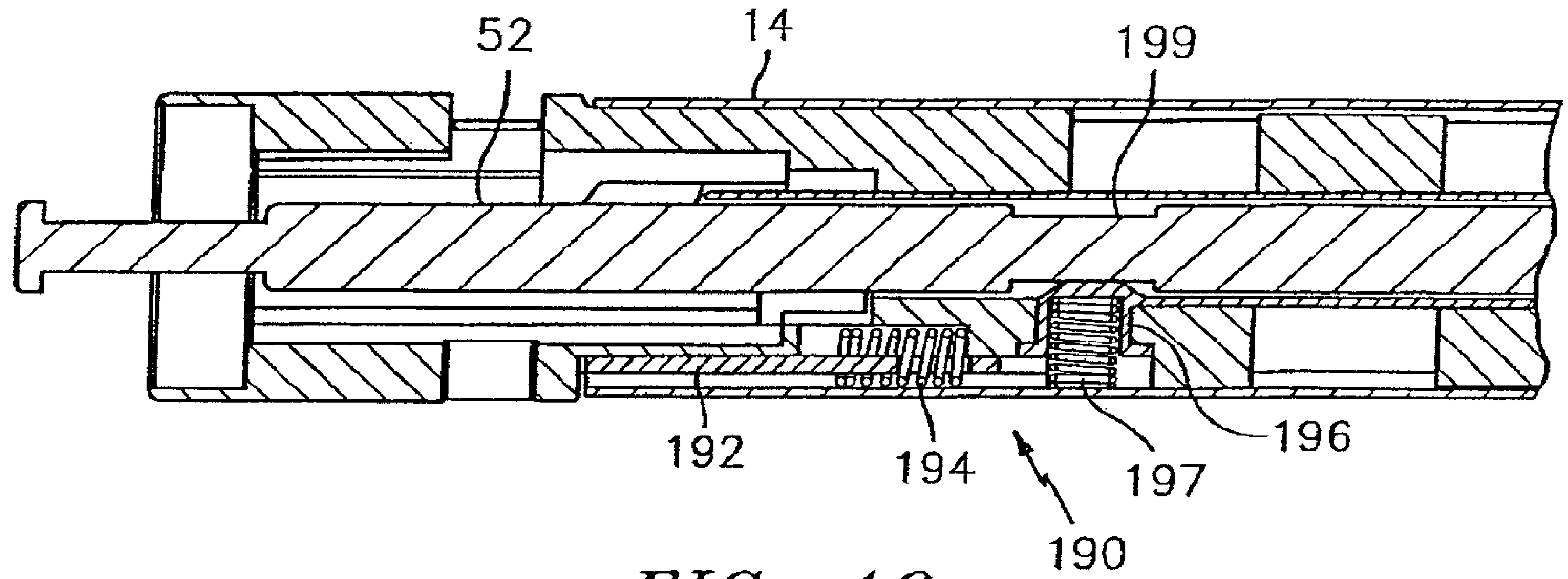

FIG. 16

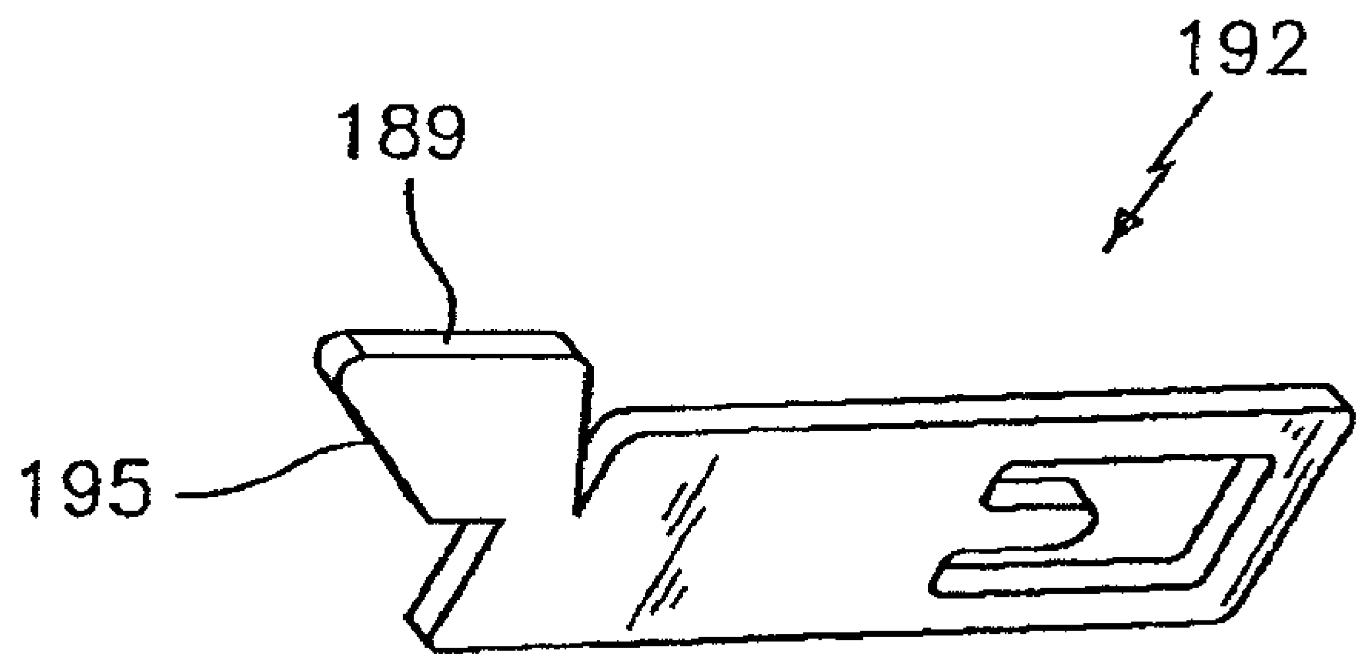

FIG. 17

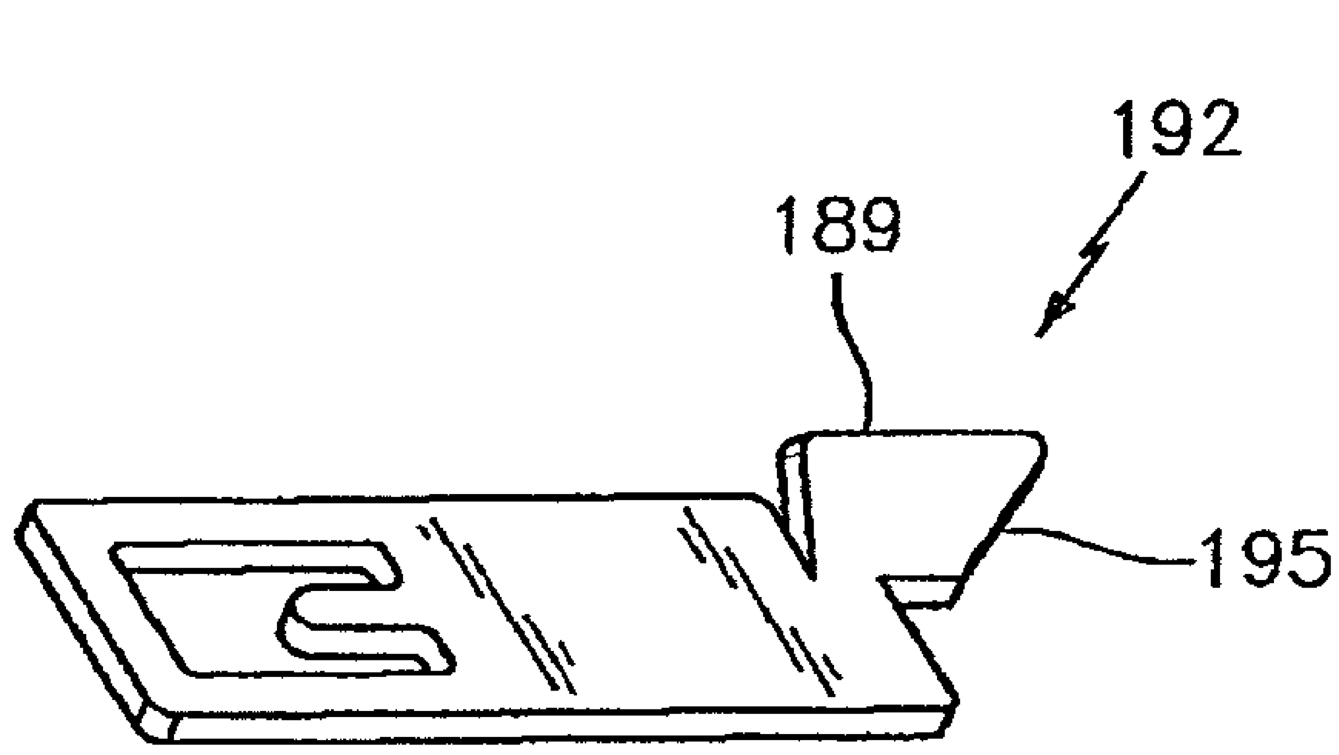

FIG. 18

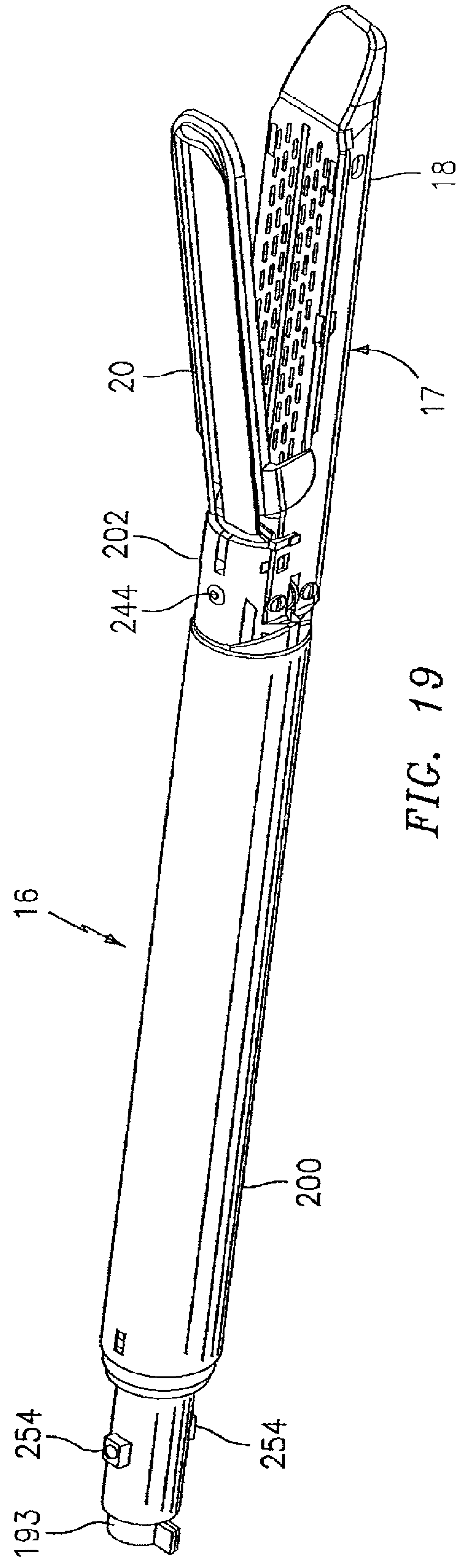

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FIG. 19

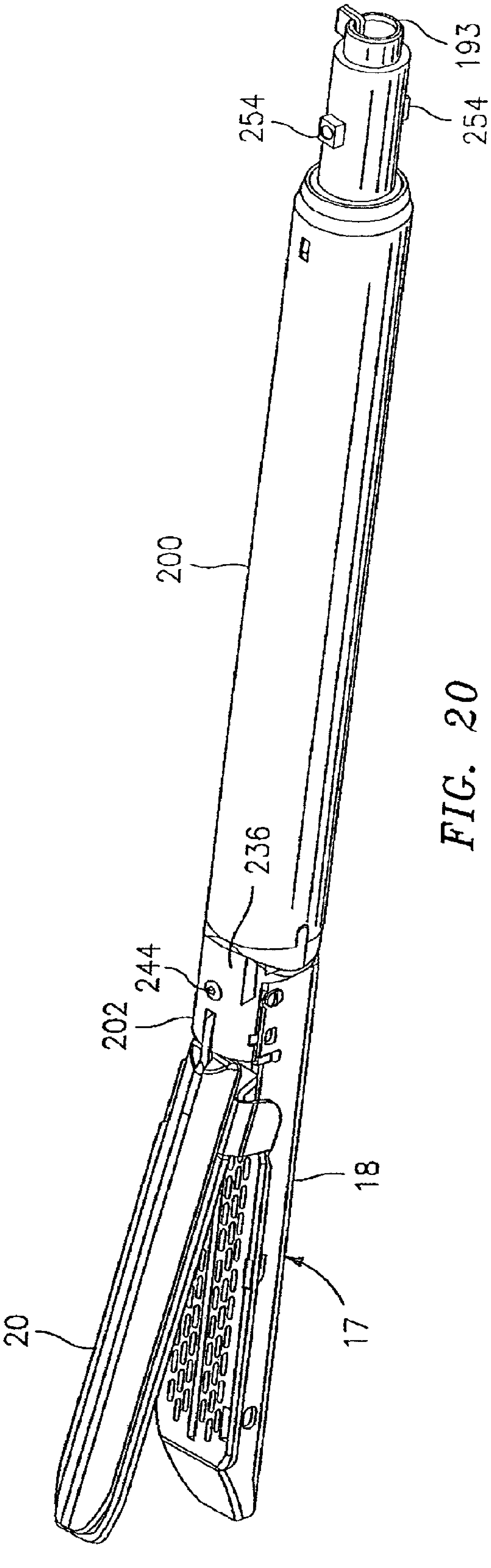

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FIG. 20

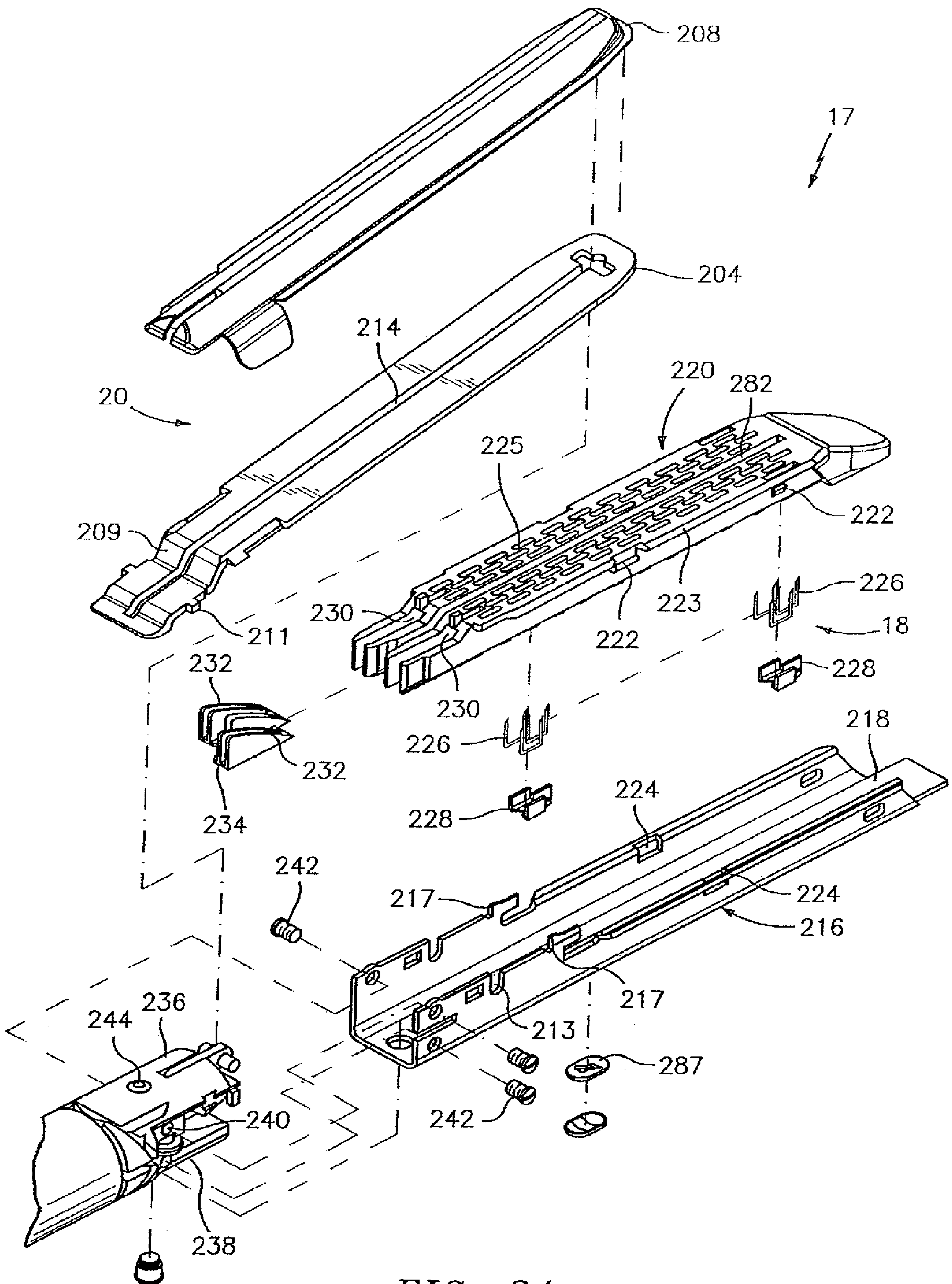
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FIG. 21

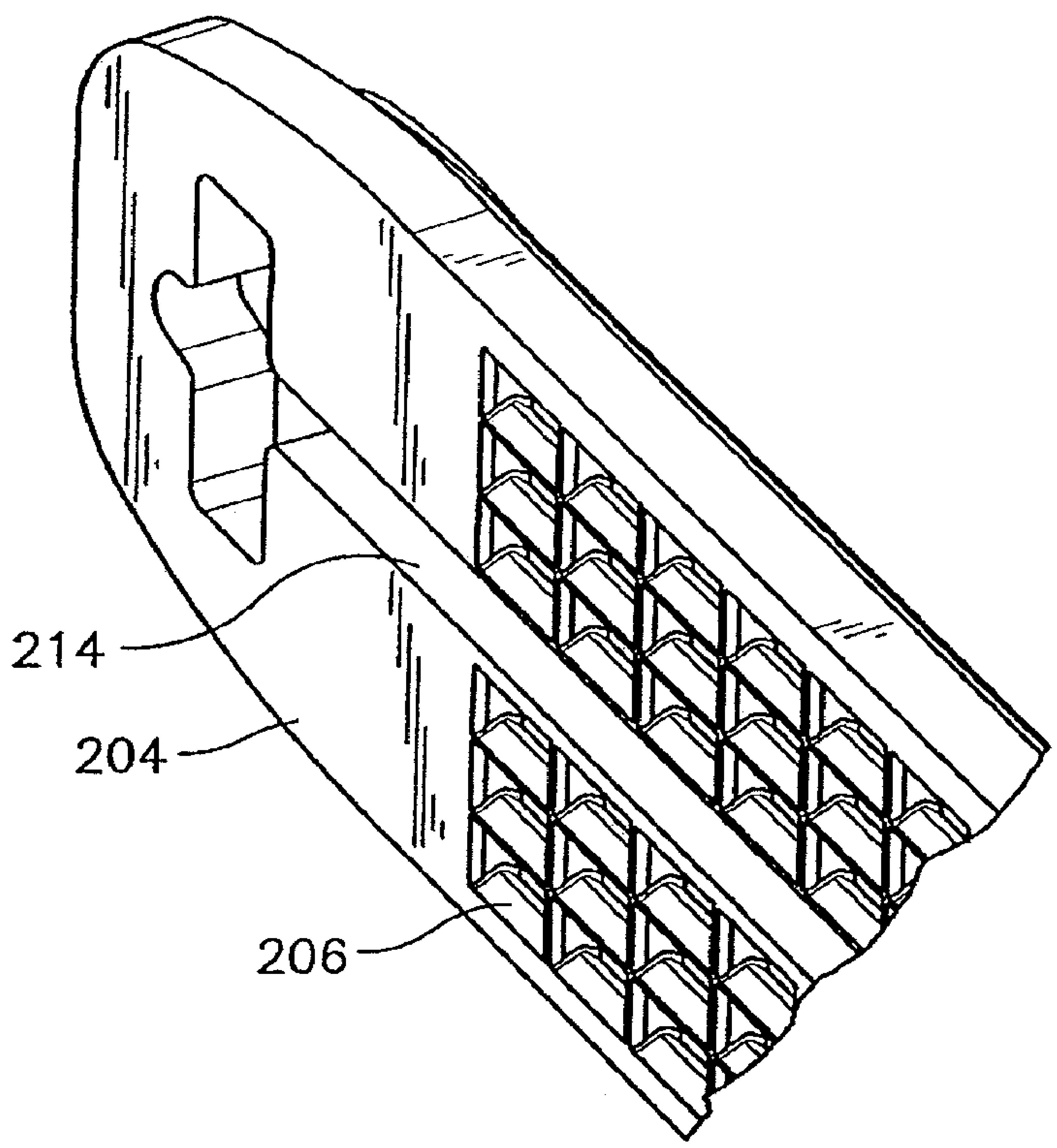
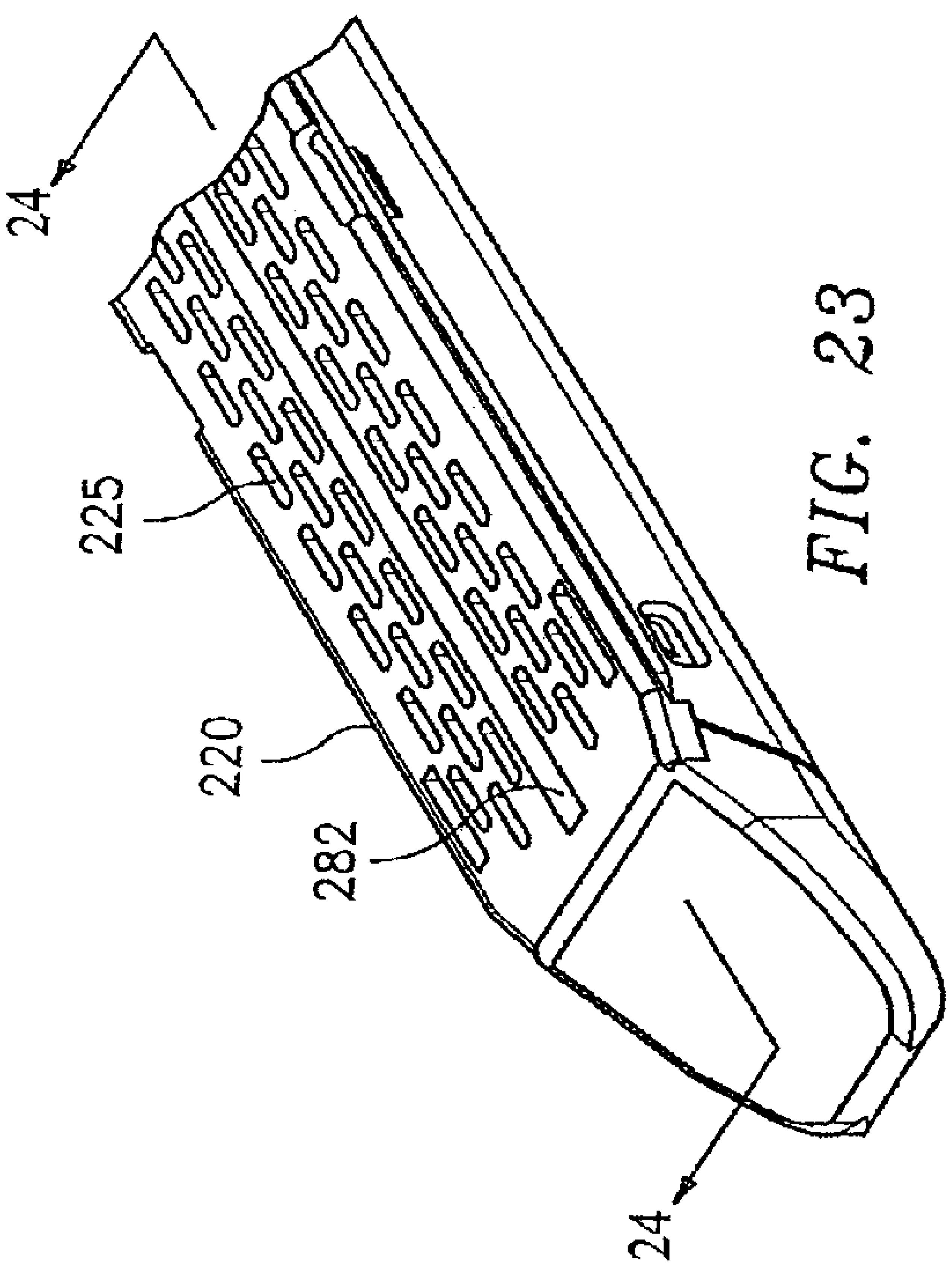


FIG. 22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225
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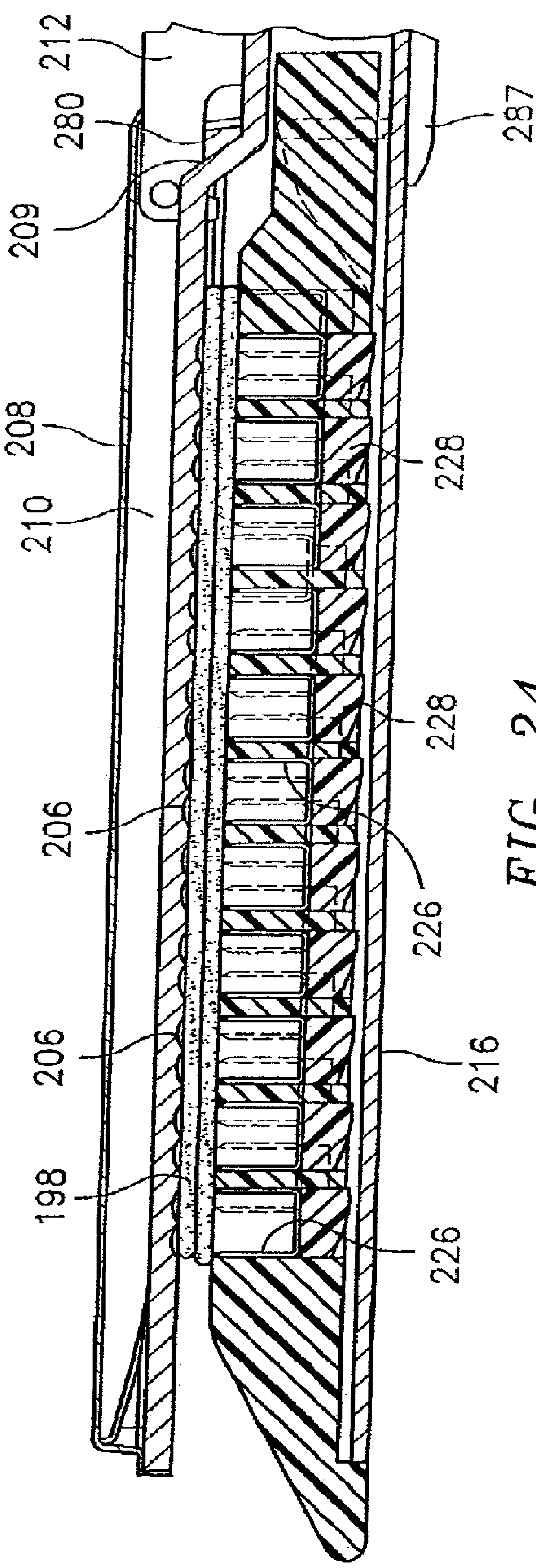
282
24

FIG. 23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226

FIG. 24

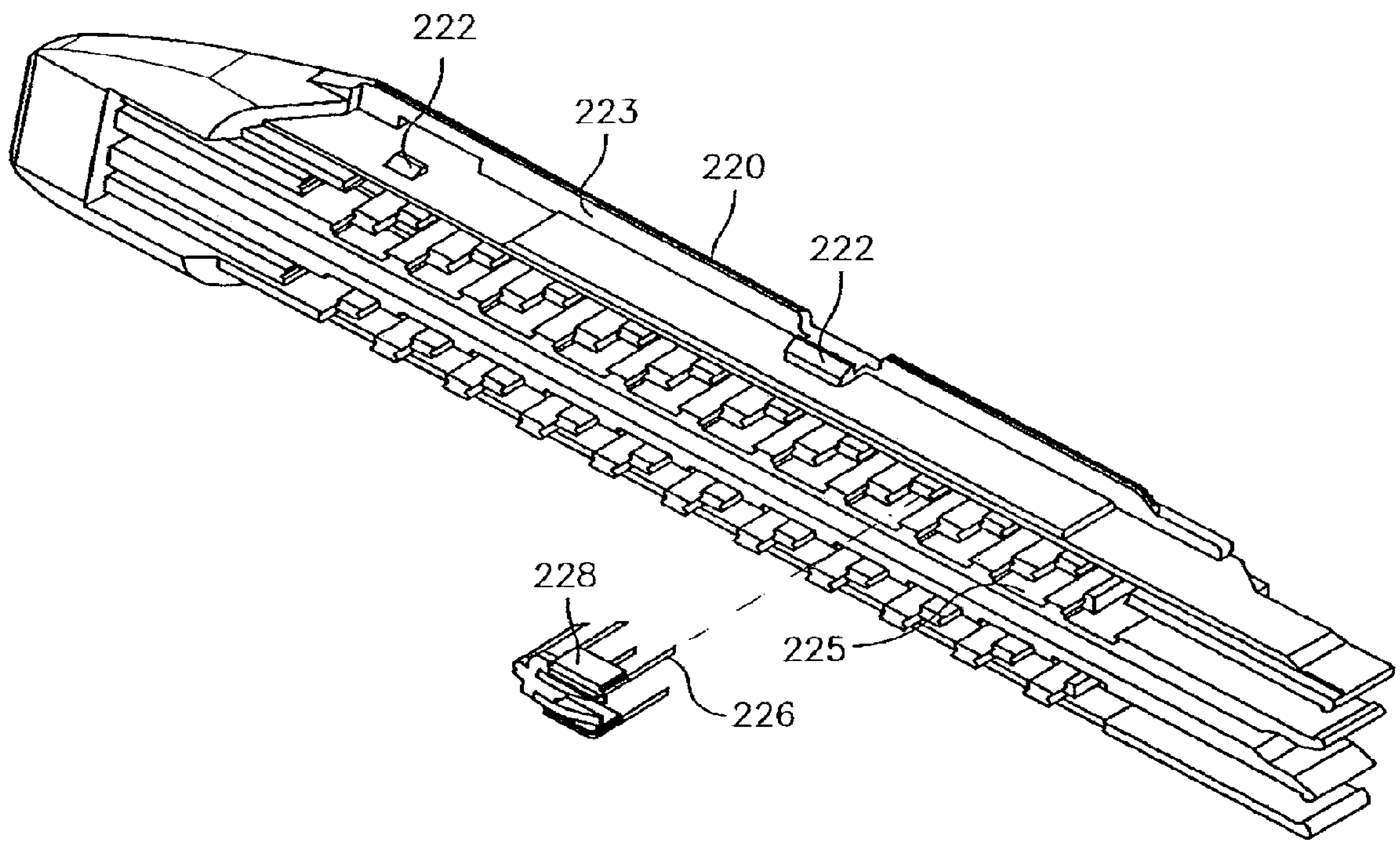


FIG. 25

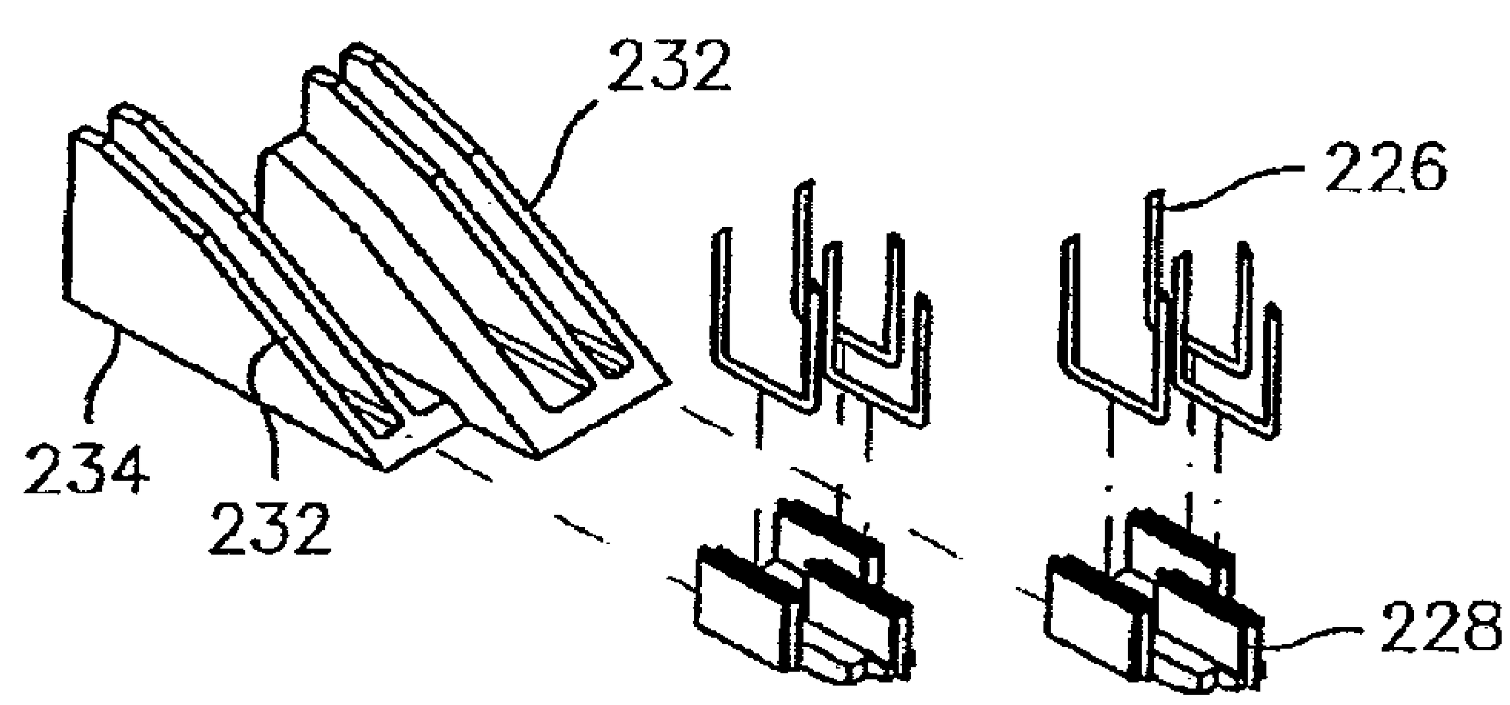
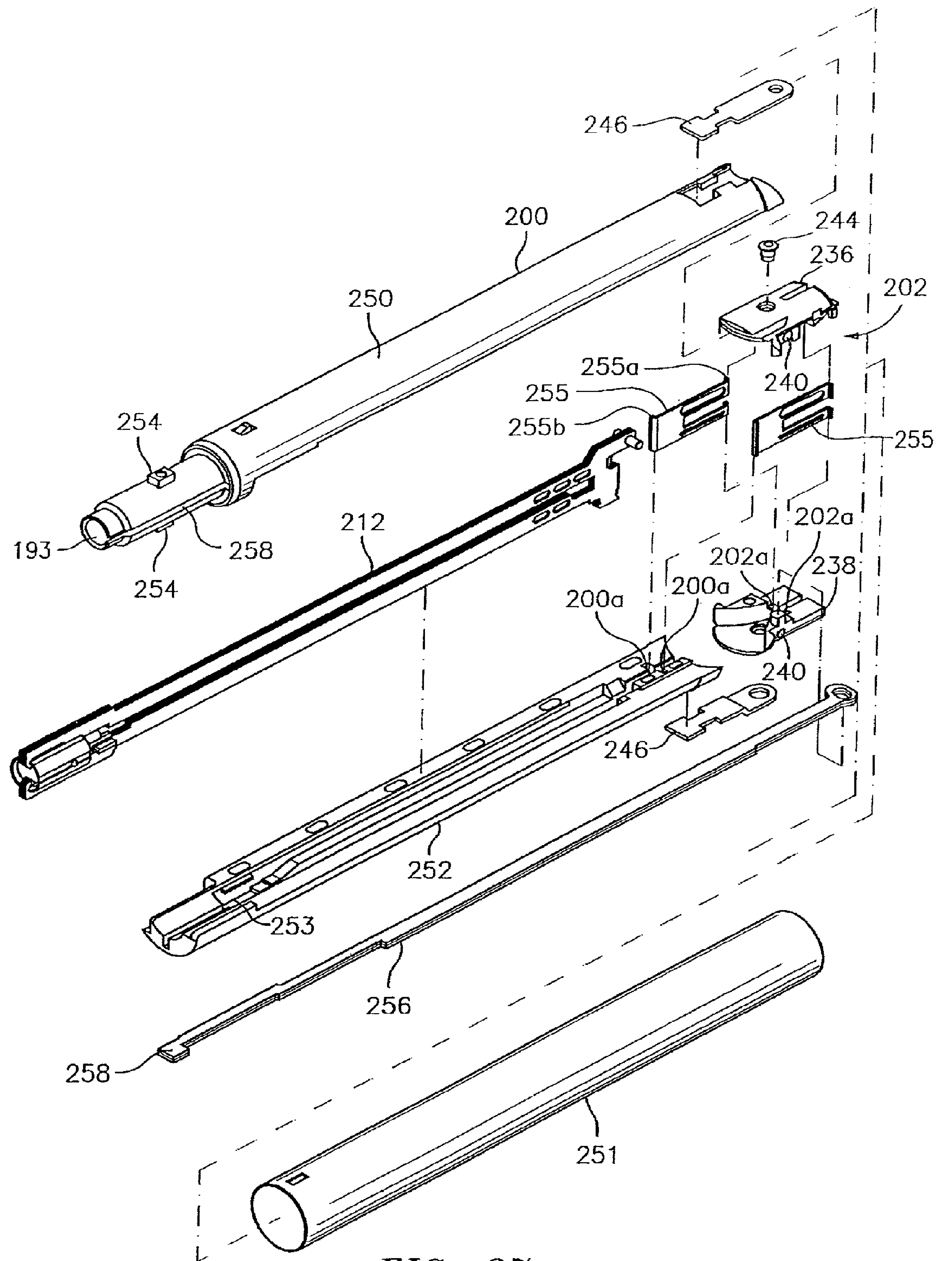


FIG. 26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200
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202
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255a
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240
255b
255
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193
258
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212
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202a
238
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200a
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FIG. 27

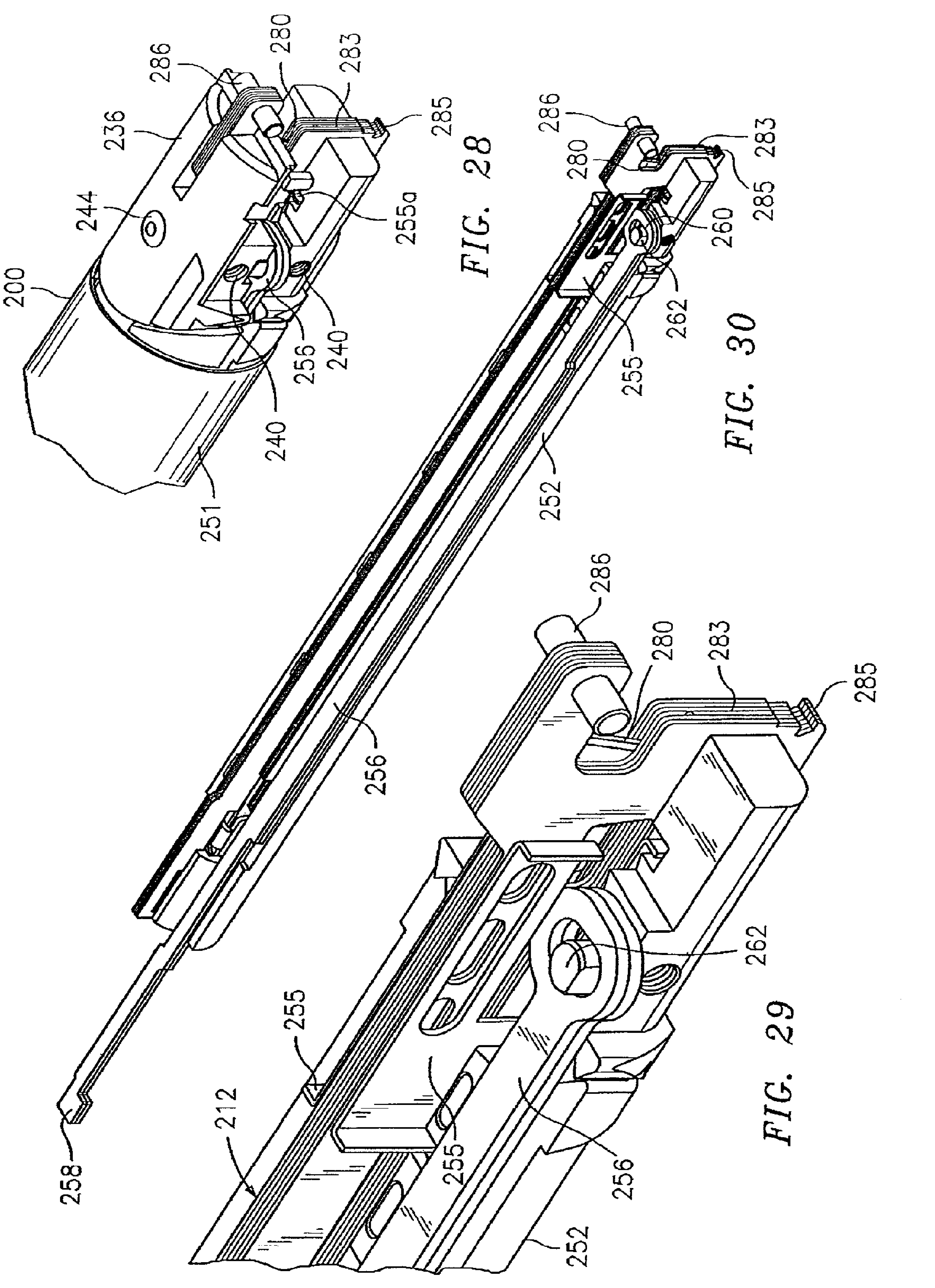
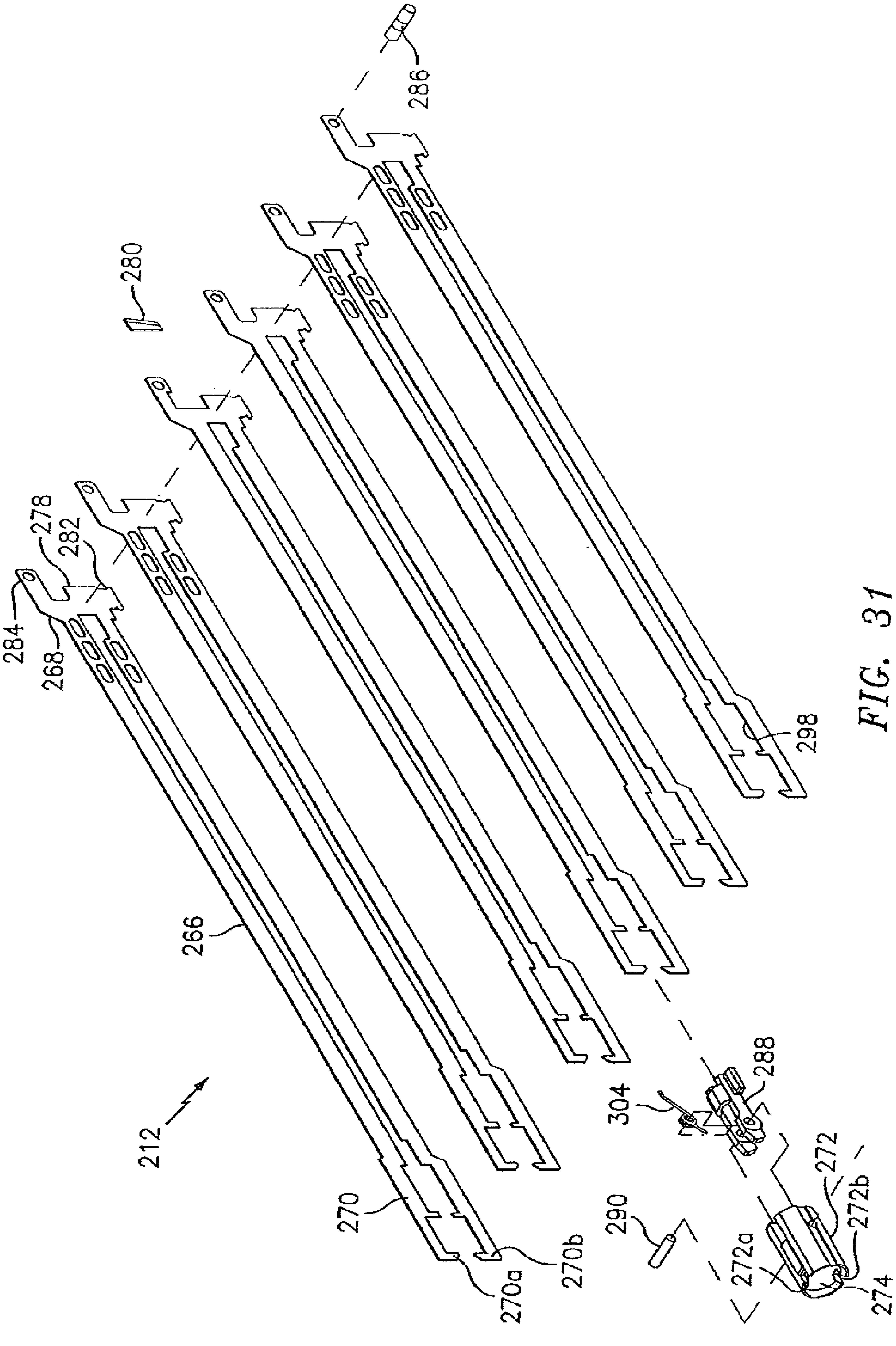


FIG. 28

FIG. 30

FIG. 29


286
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270b
298
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288
290
272
272b
272a
274

FIG. 31

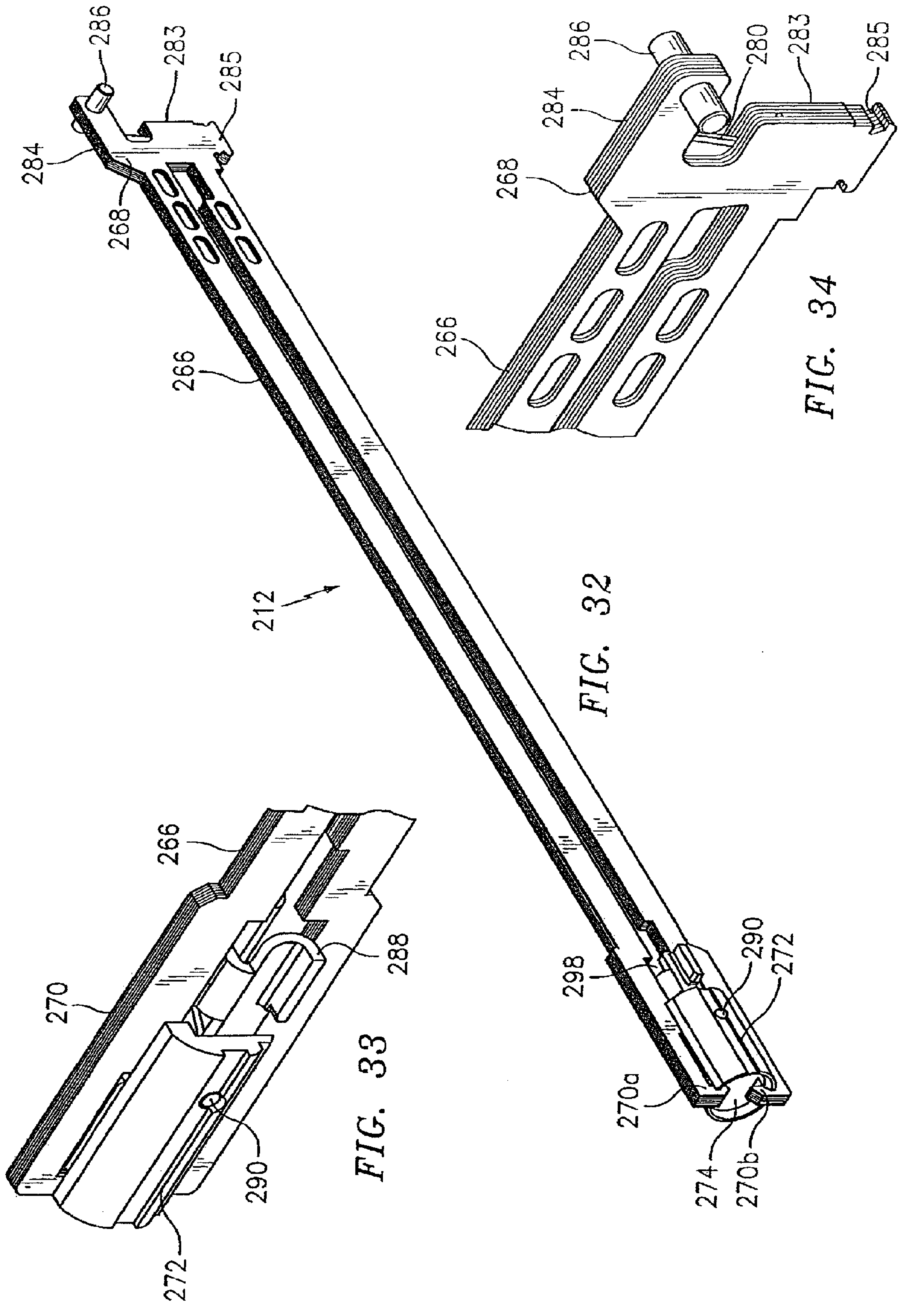


FIG. 32

FIG. 34

FIG. 33

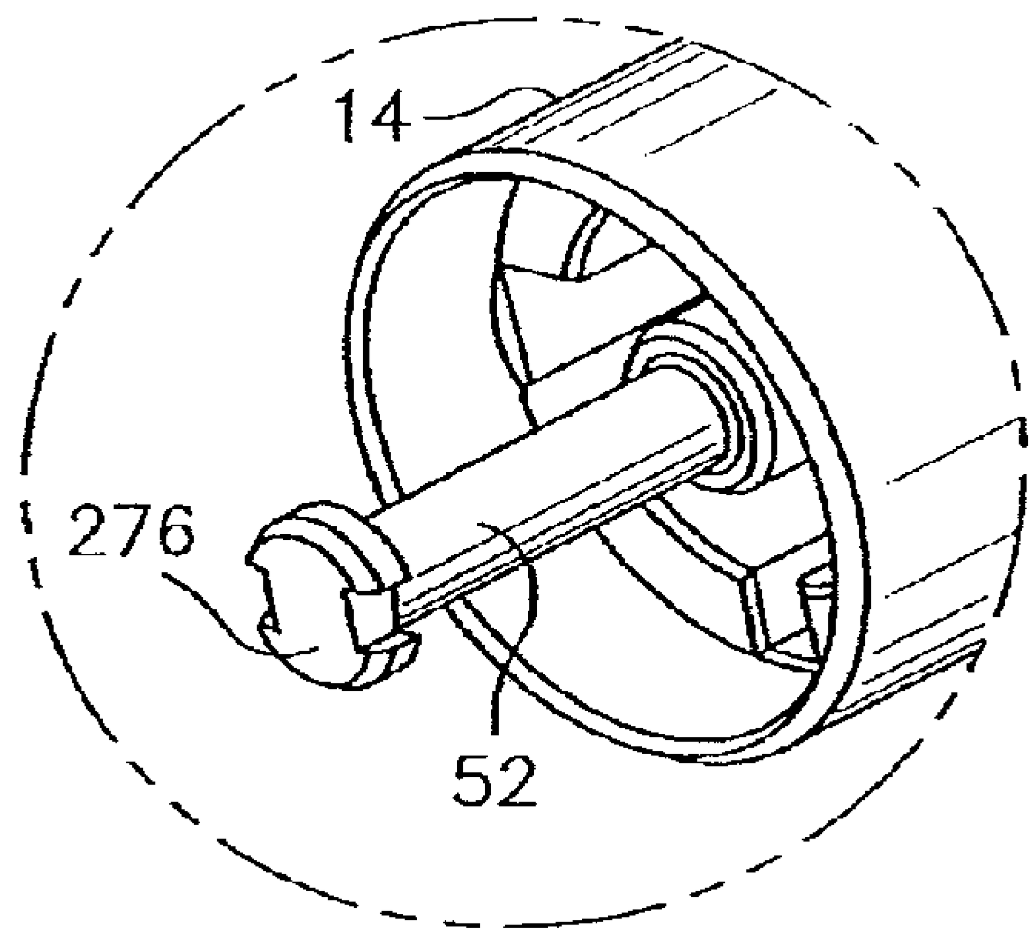


FIG. 35

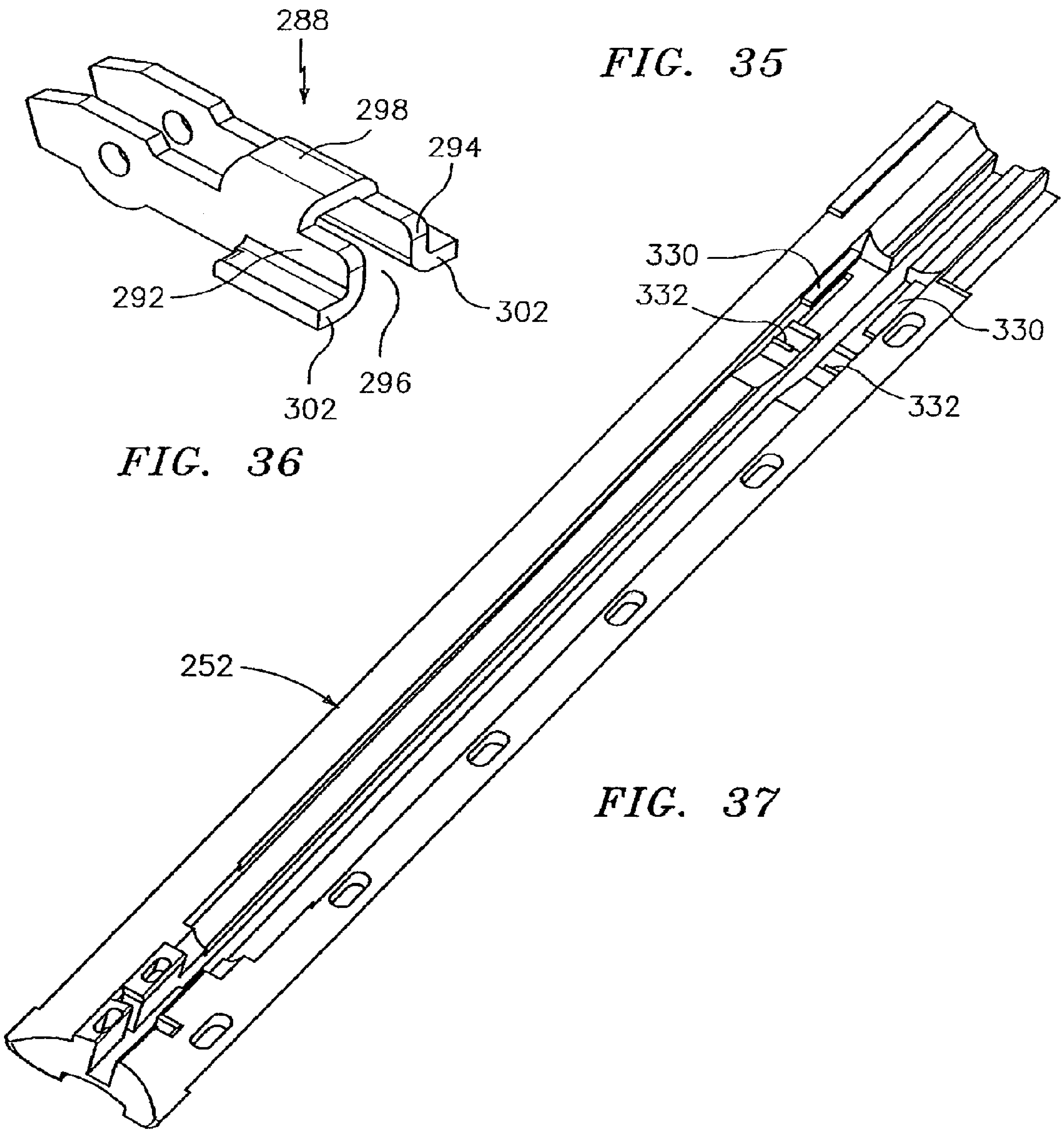


FIG. 36

FIG. 37

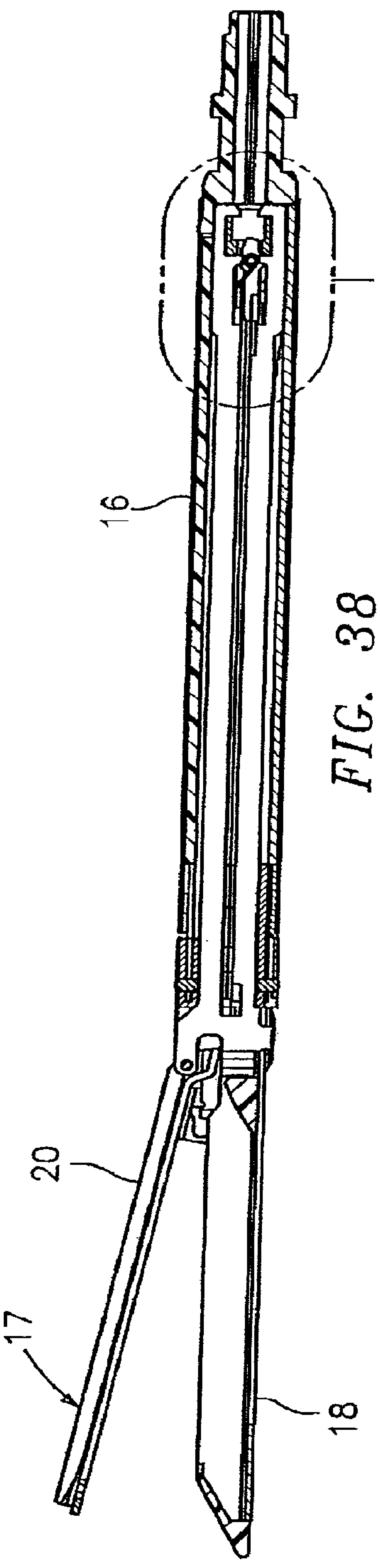


FIG. 38

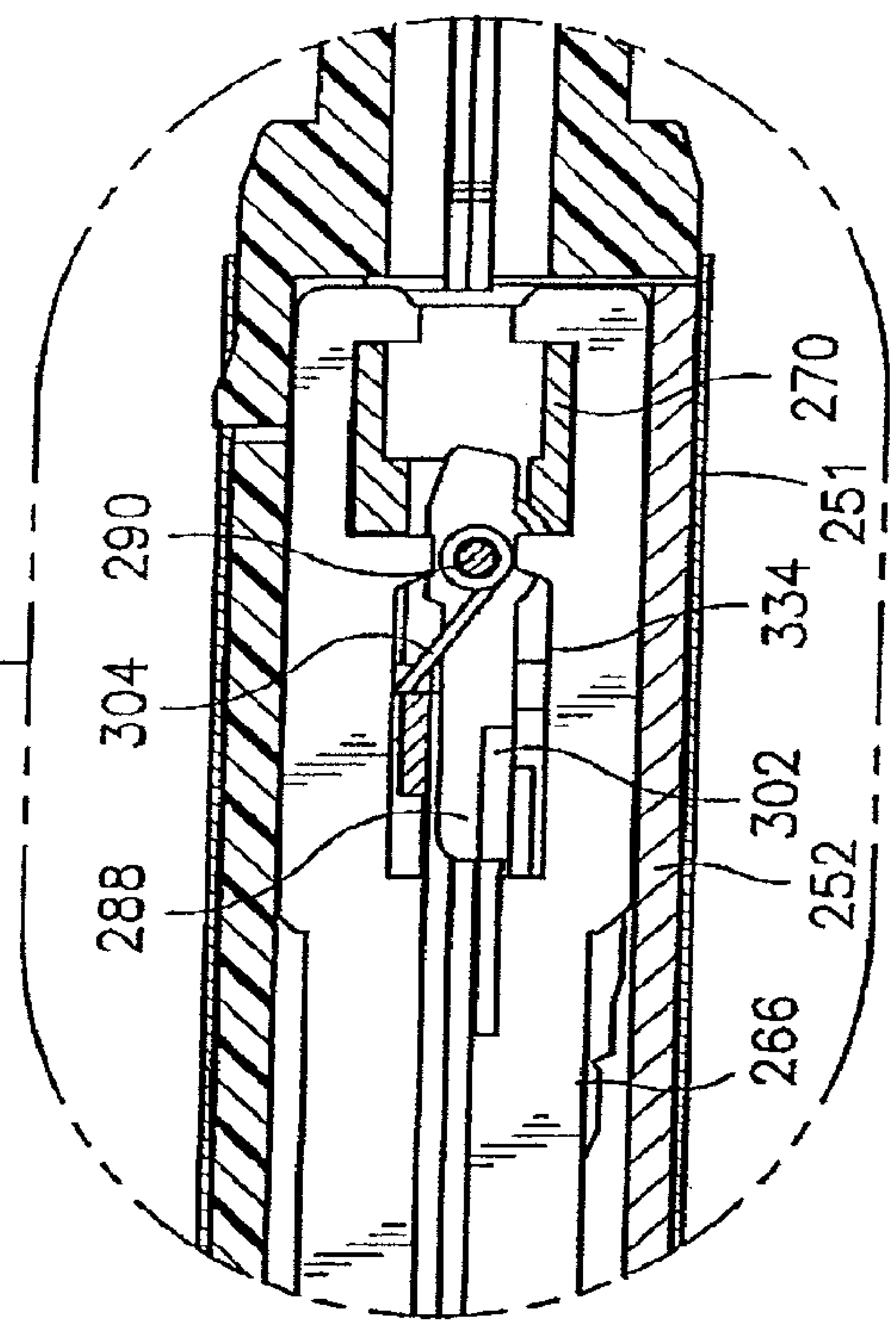


FIG. 39

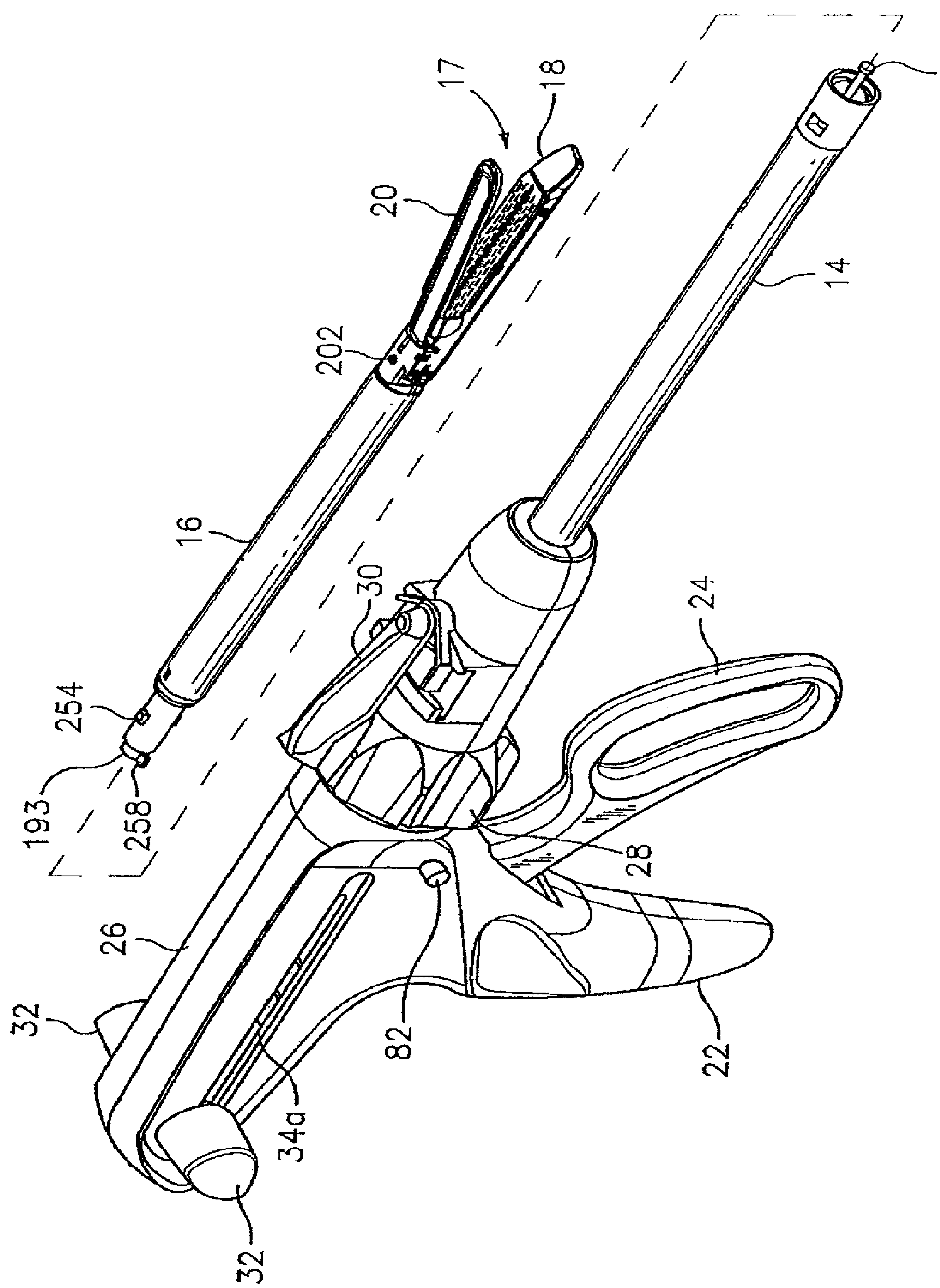
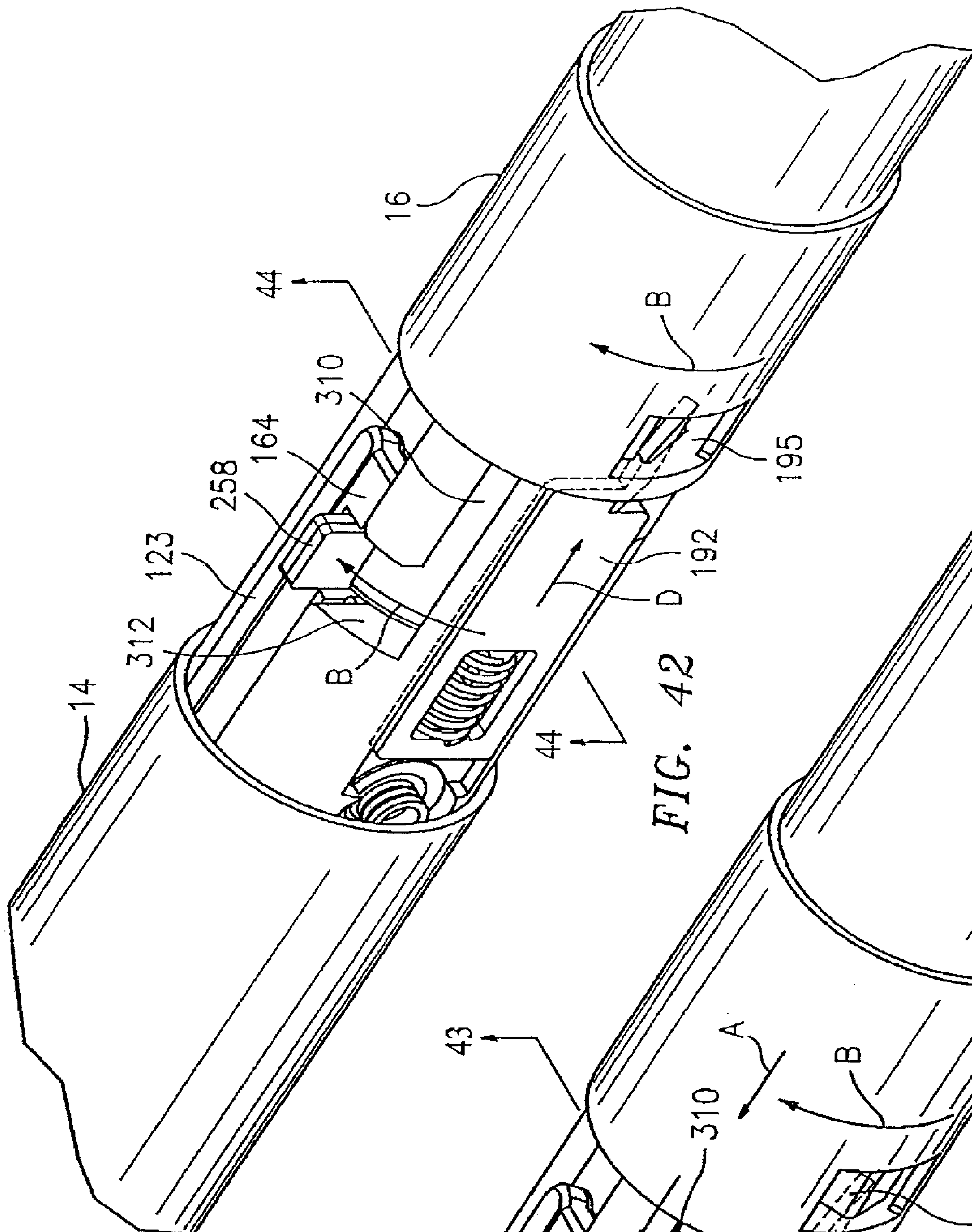


FIG. 40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44
310
164
258
123
312
14
B
195
192
D
B
44

FIG. 42

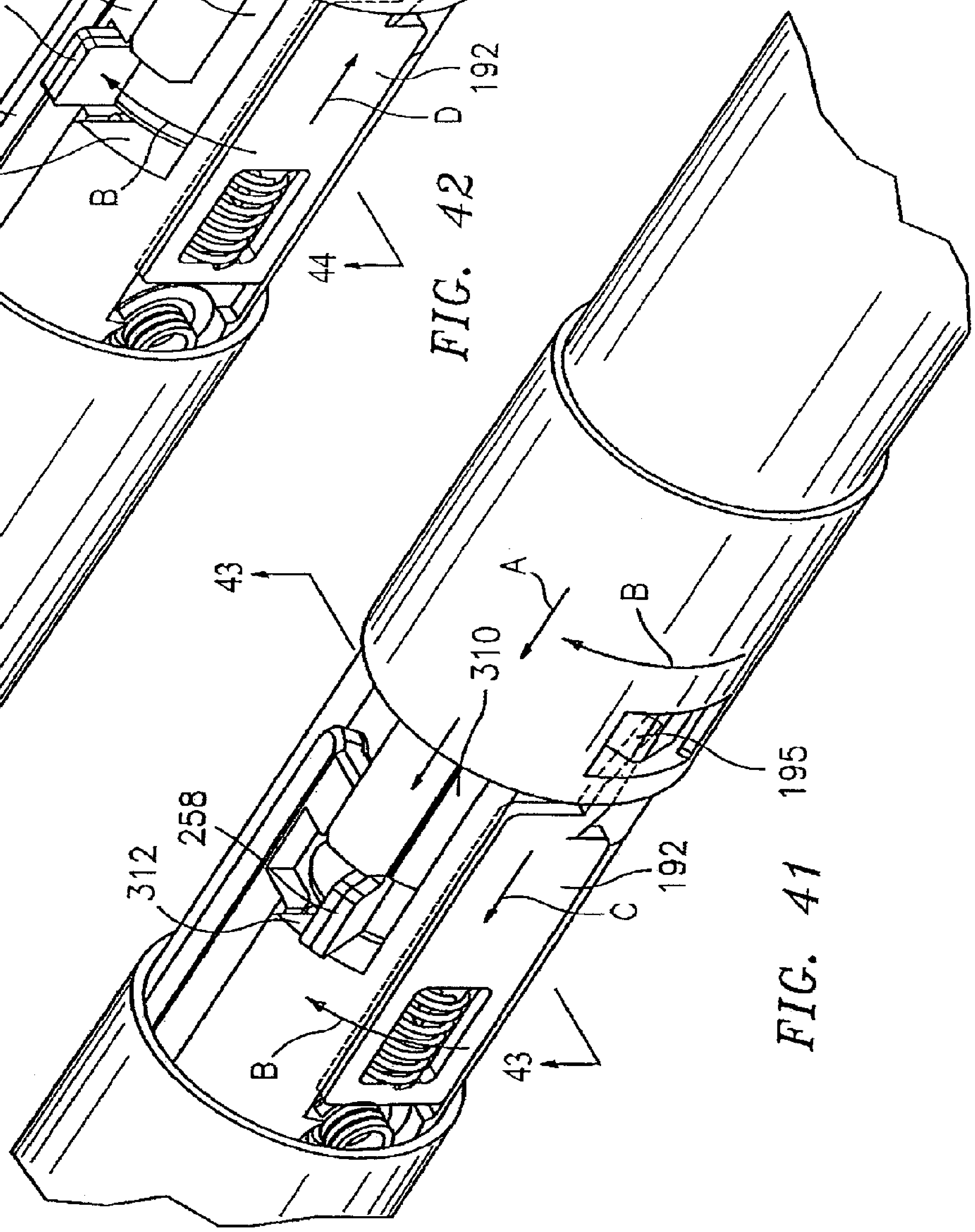

43
A
B
310
195
258
312
192
C
B
43

FIG. 41

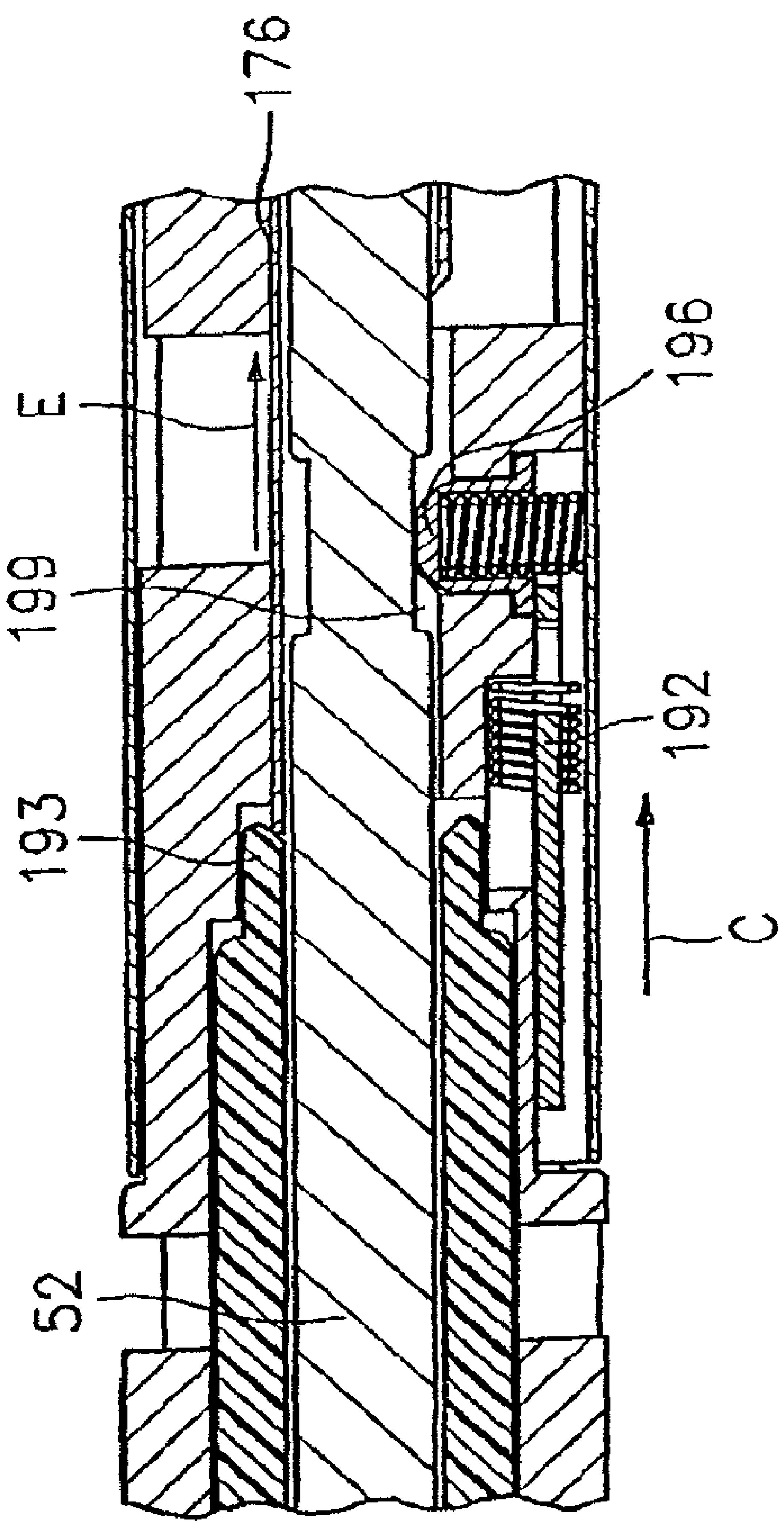
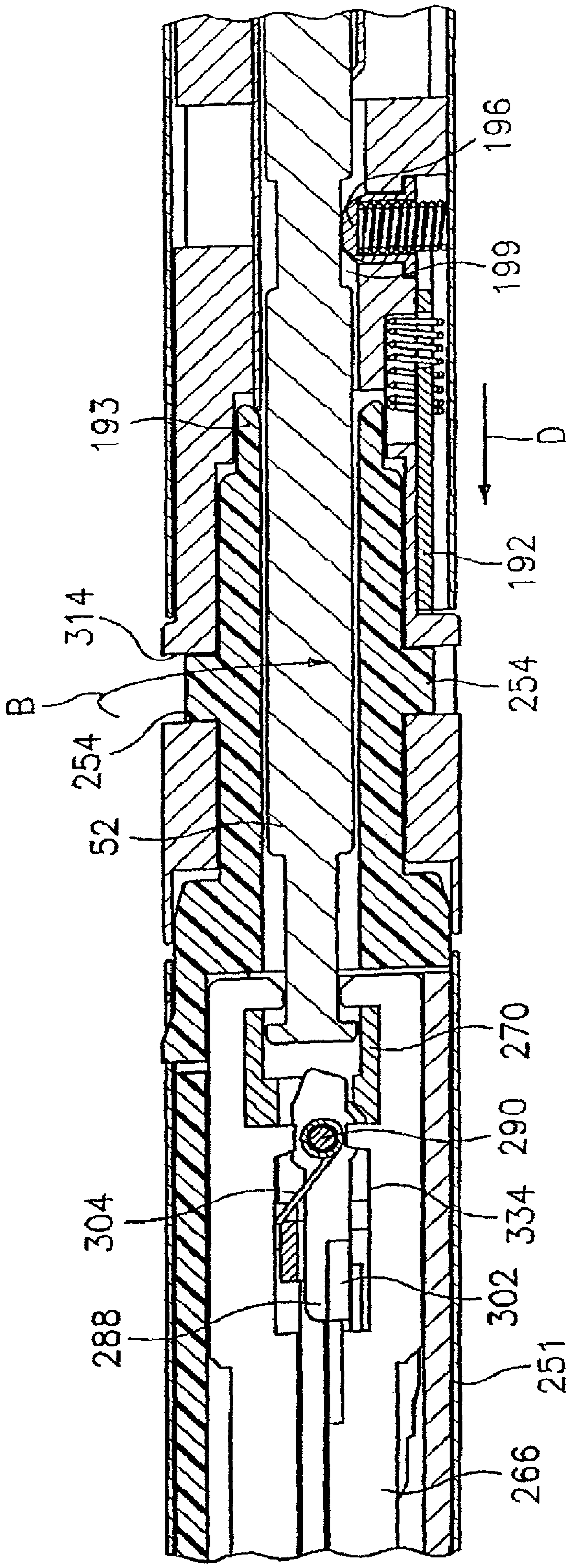

176
E
199
193
52
196
192
C

FIG. 43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314
B
254
52
304
288
196
199
D
192
254
270
290
334
302
251
266

FIG. 44

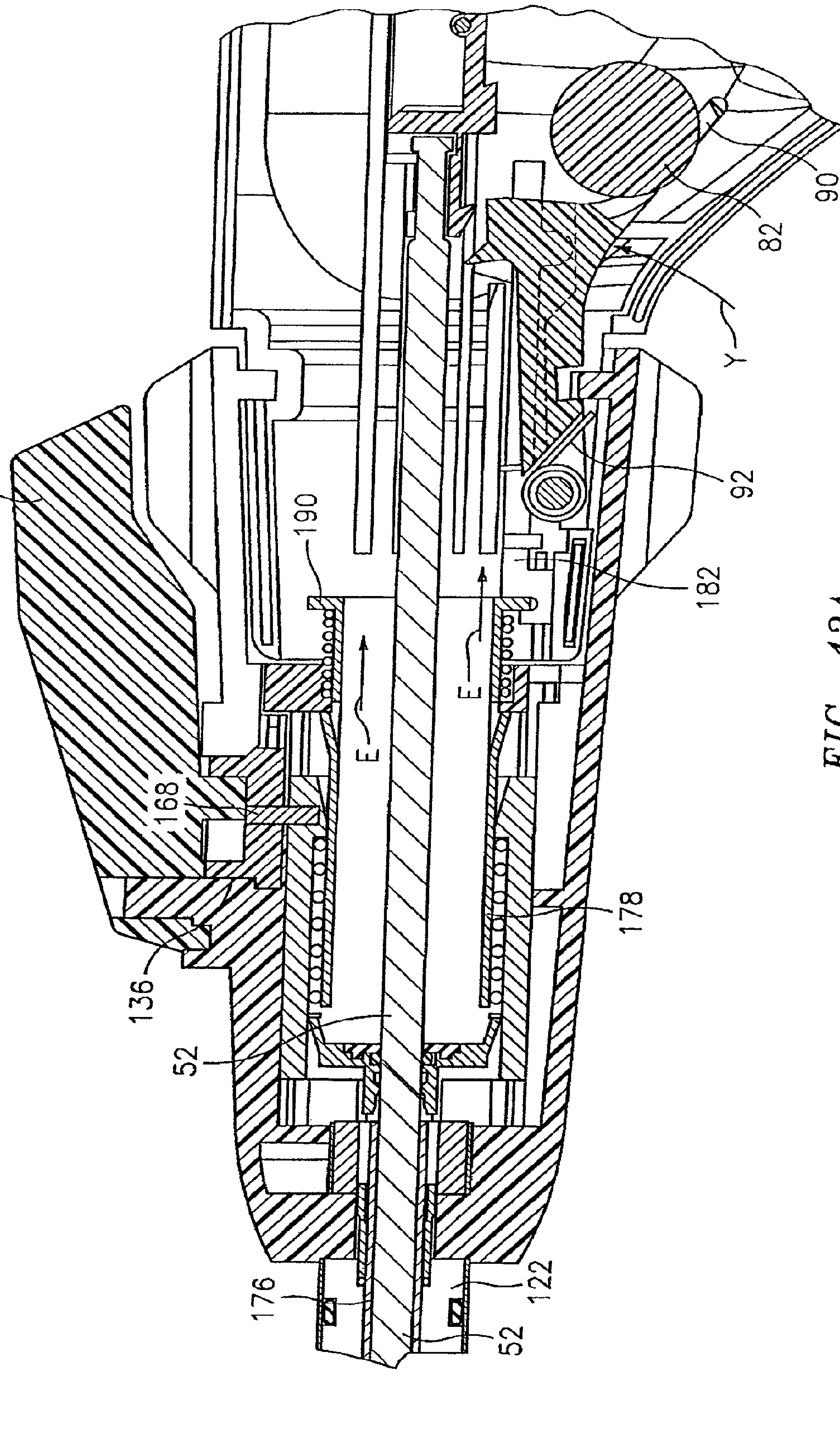

FIG. 43A

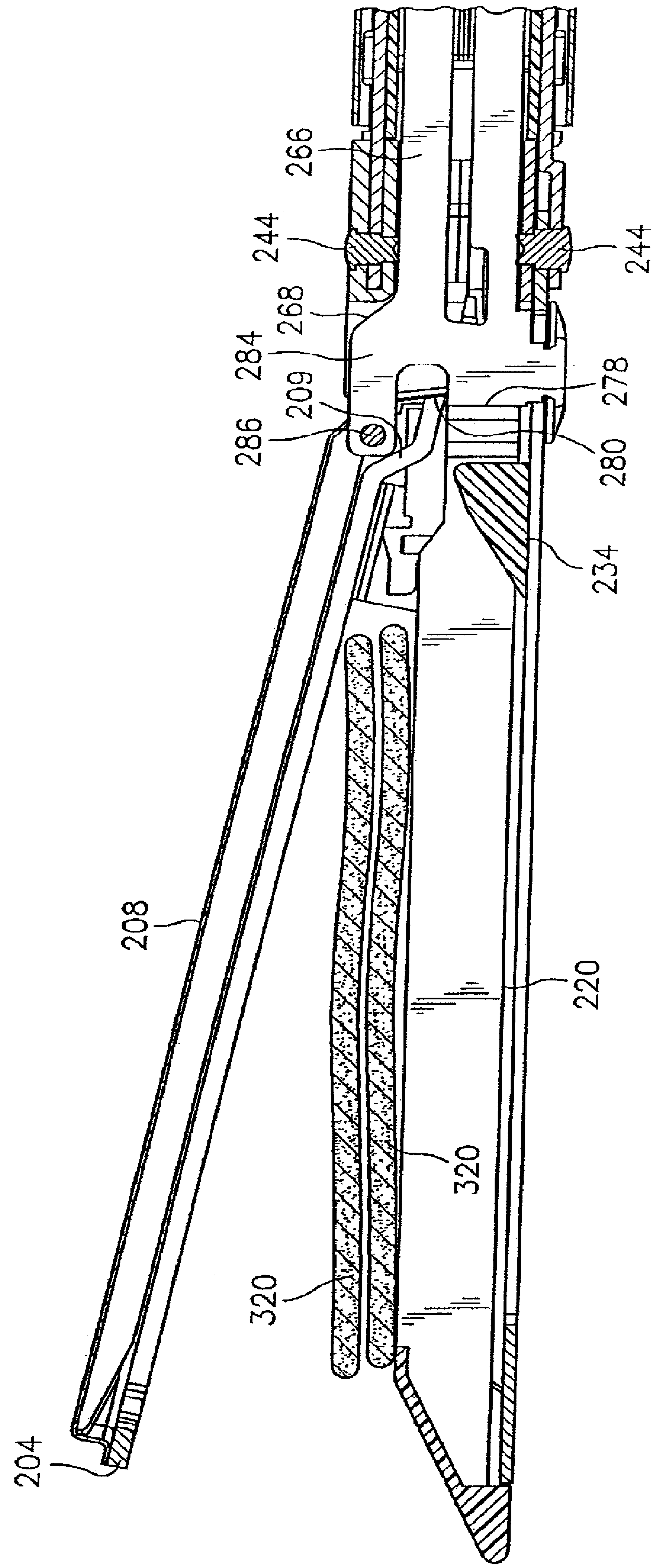

FIG. 45

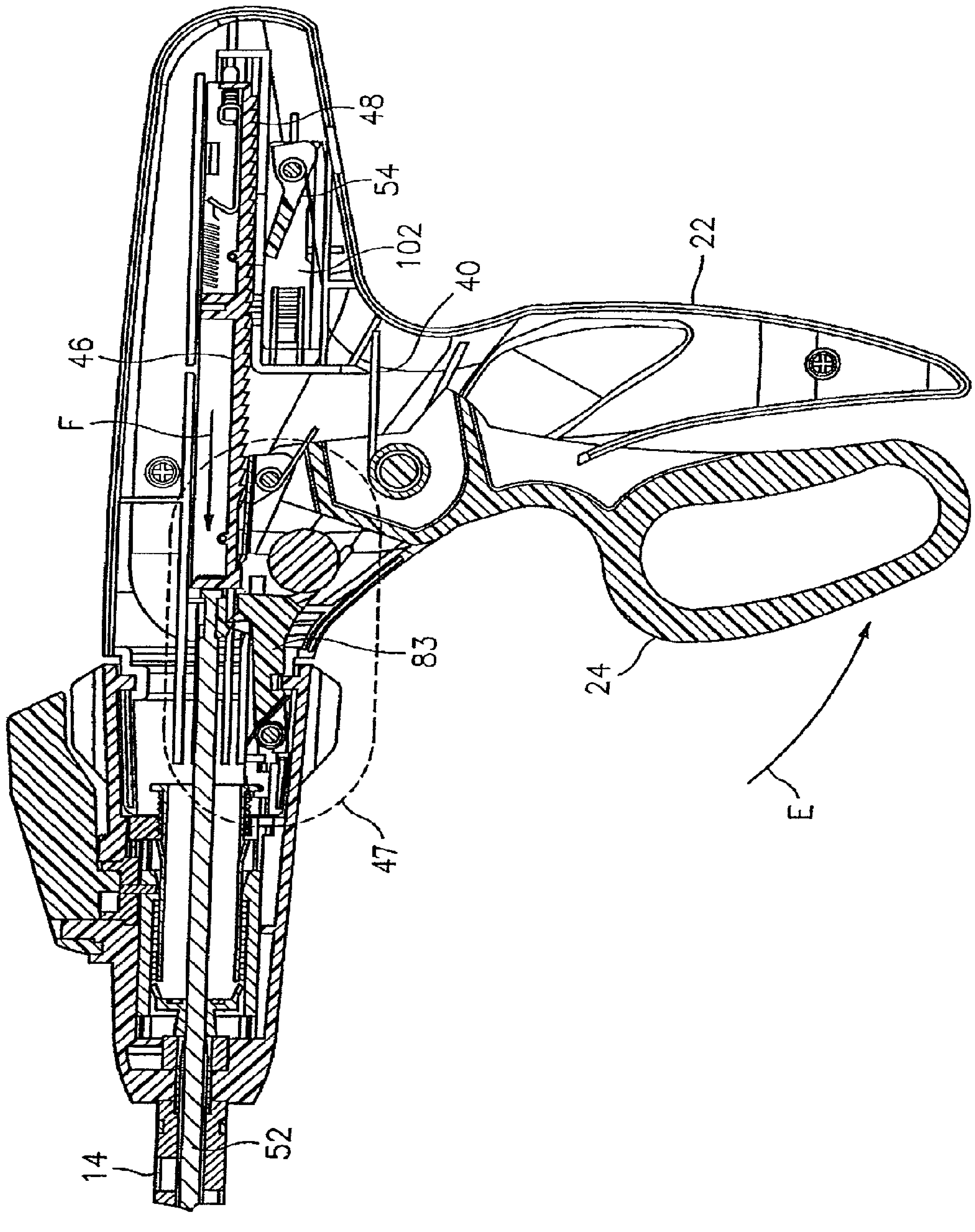

FIG. 46

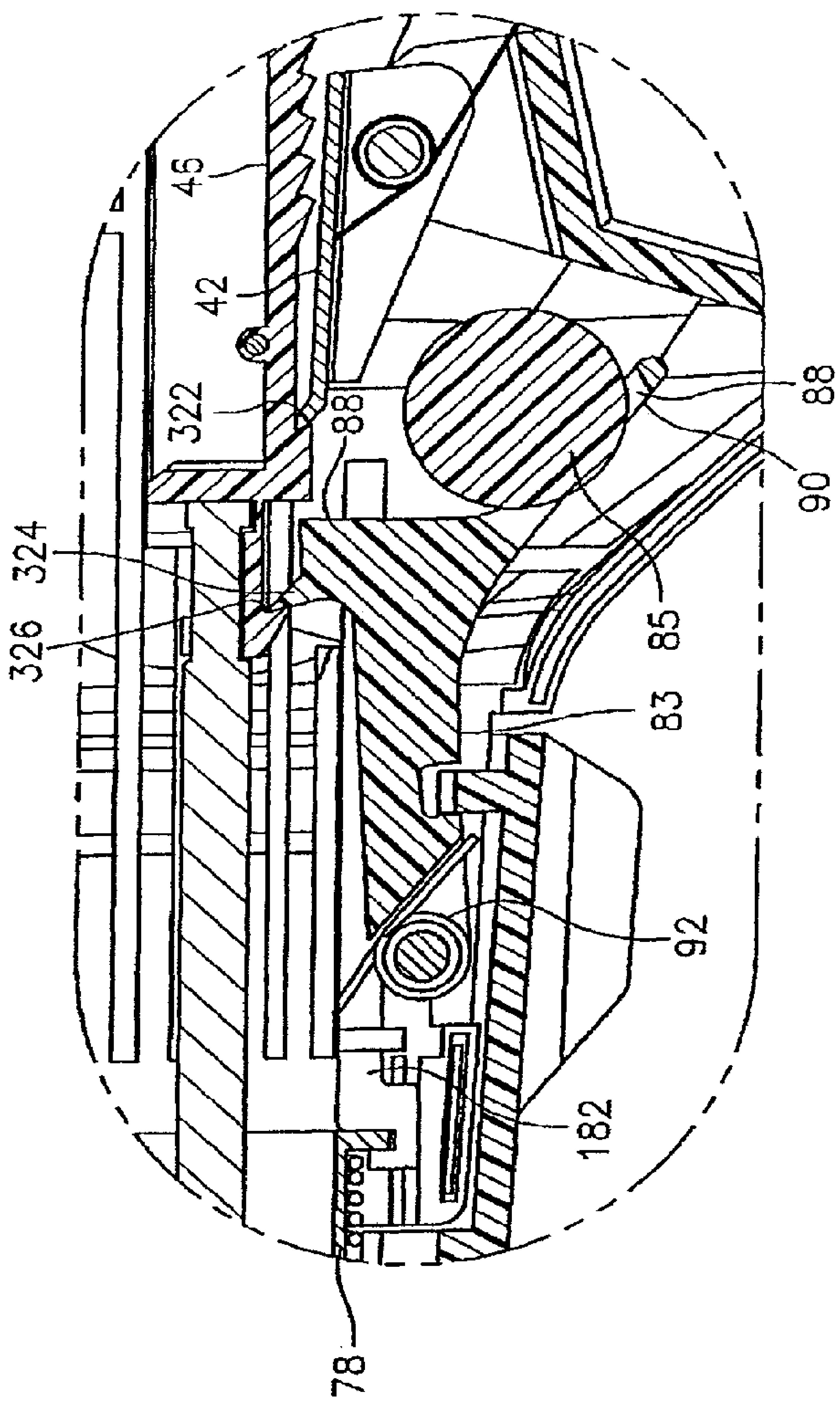

FIG. 47

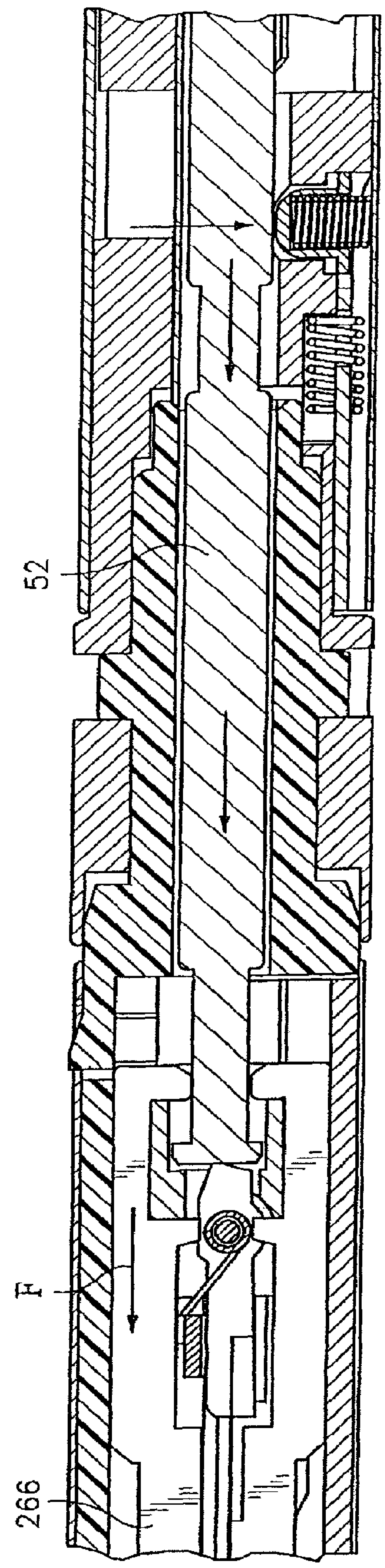

FIG. 48

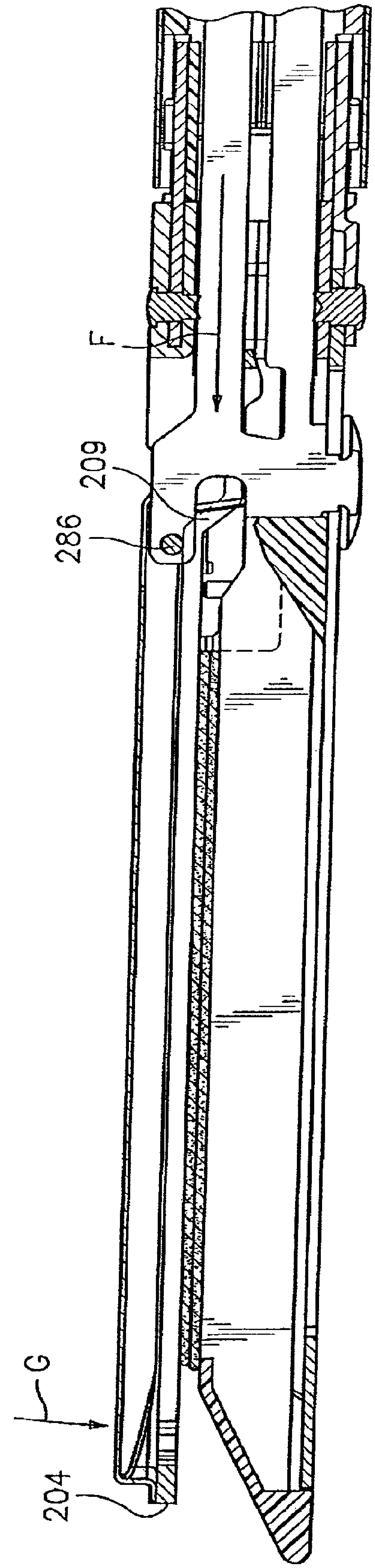

FIG. 49

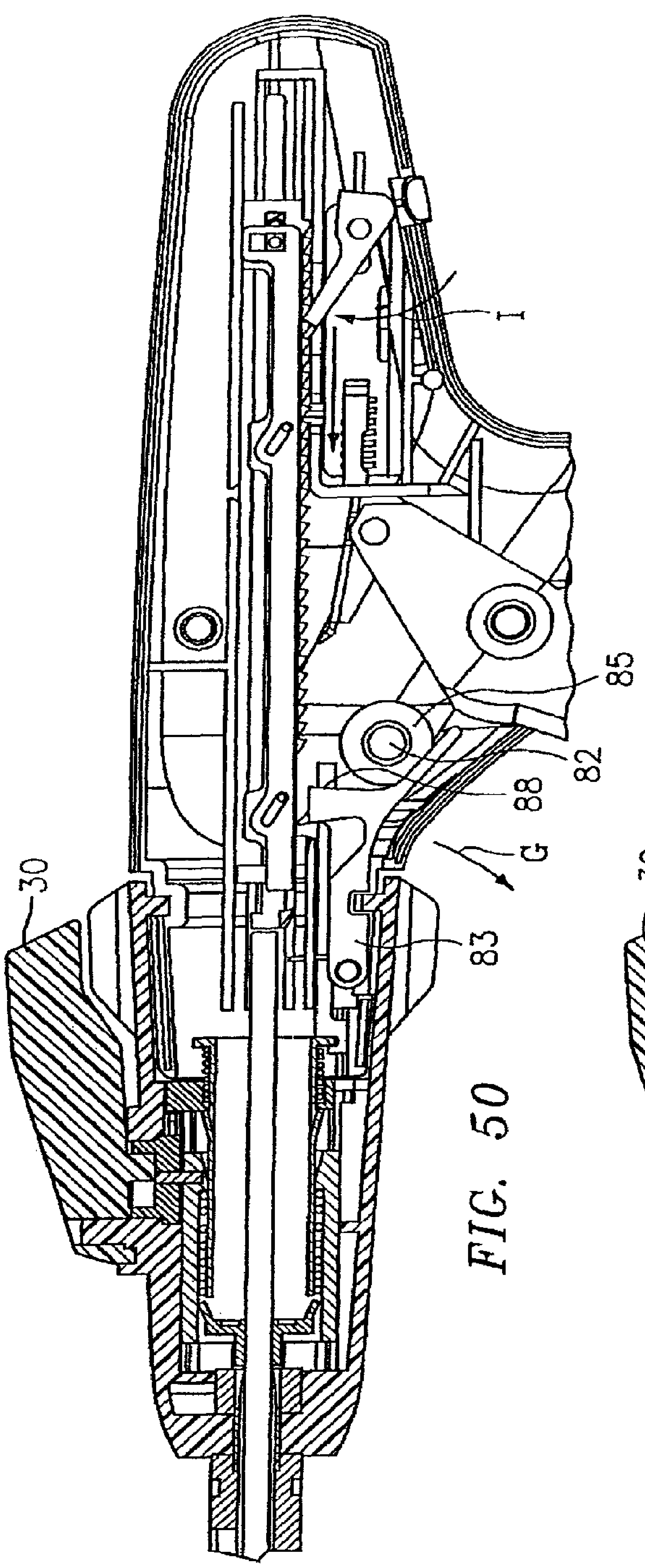

FIG. 50

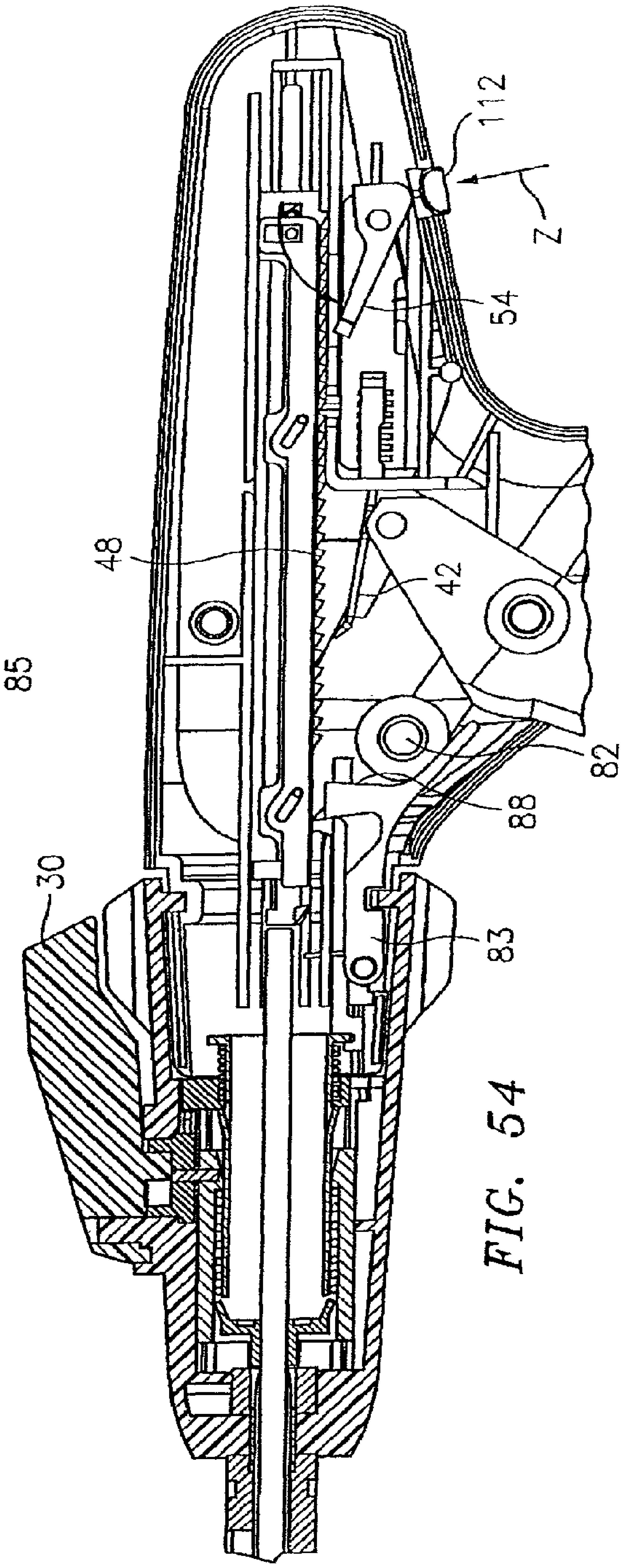

FIG. 54

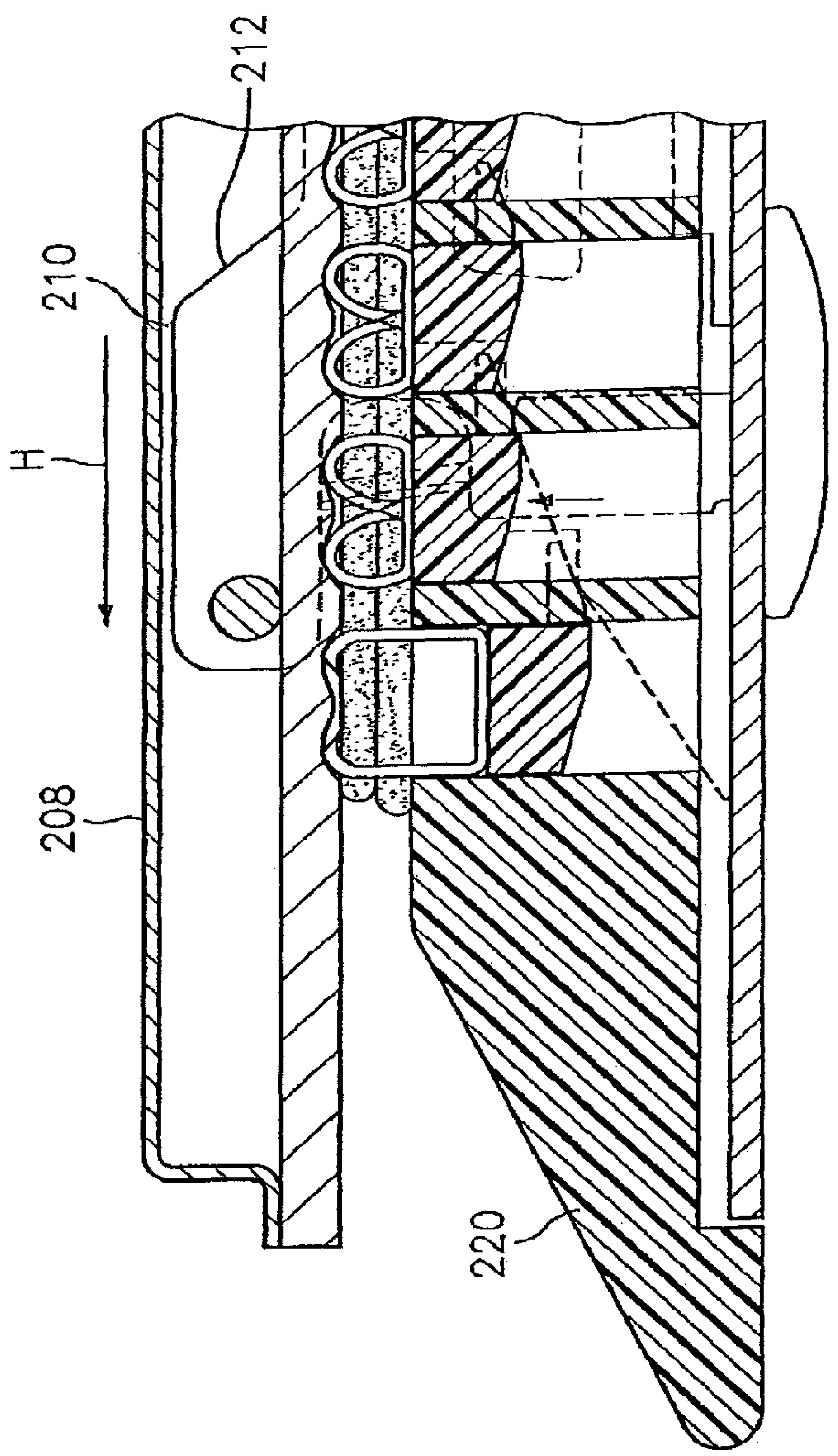

FIG. 51

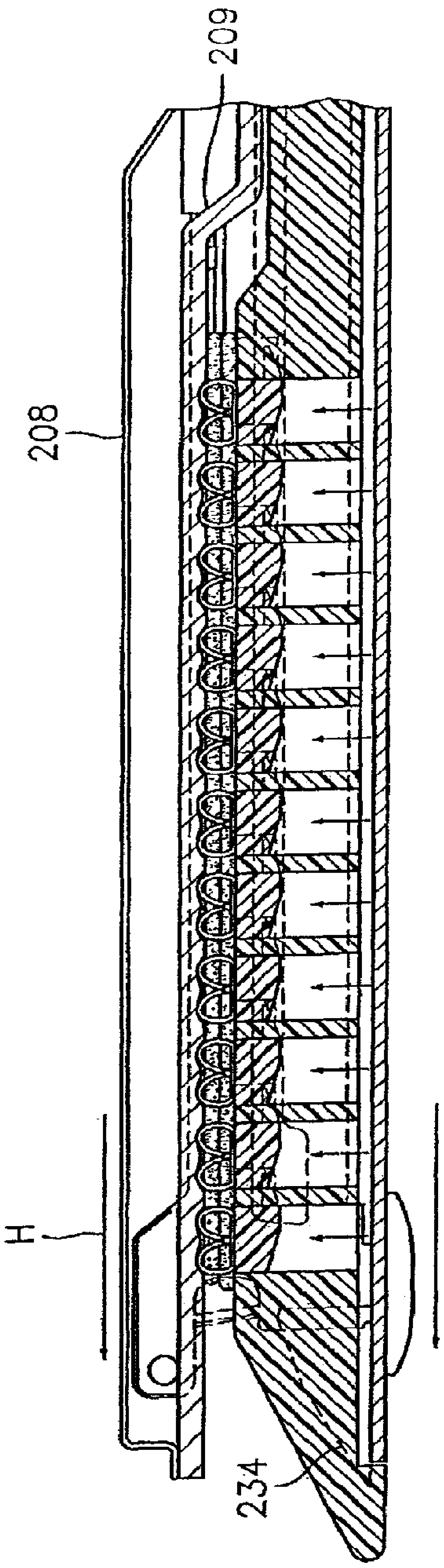

FIG. 52

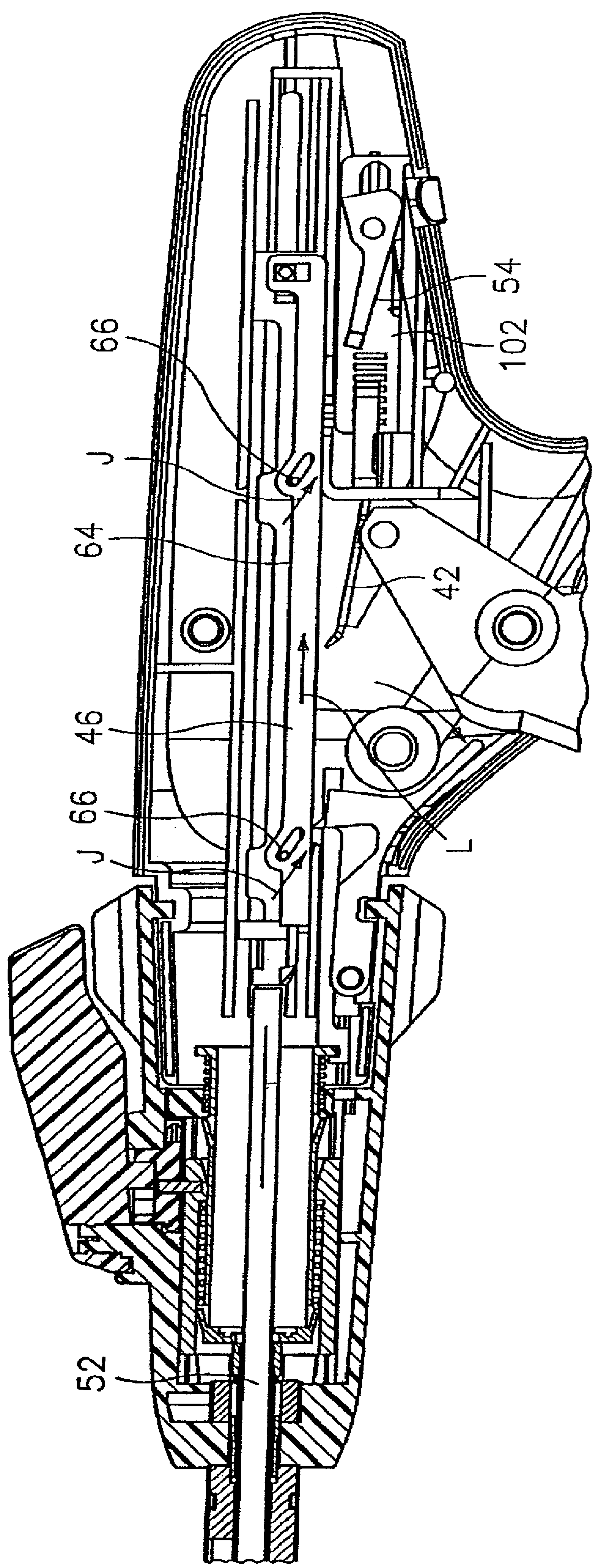

FIG. 53

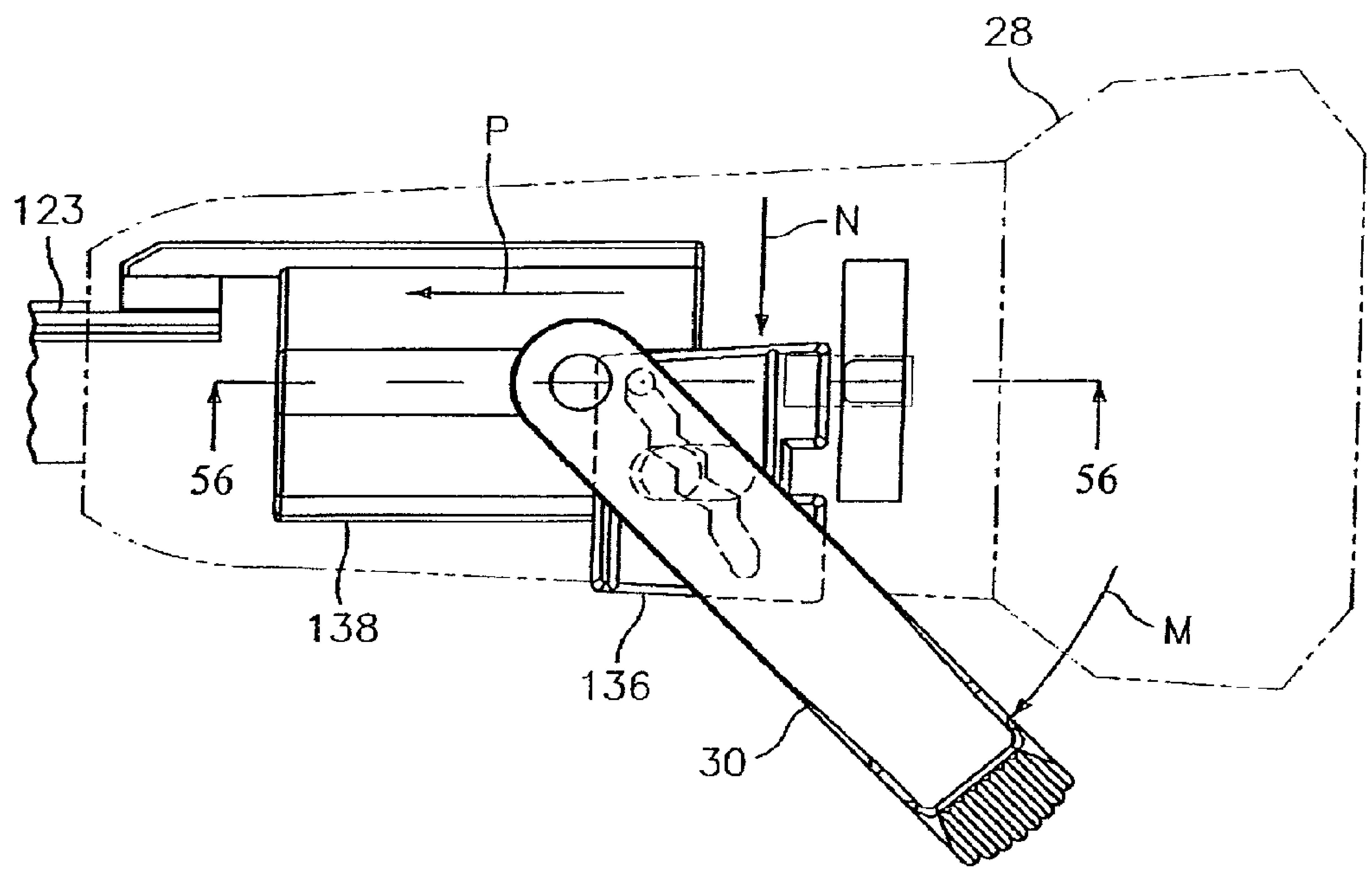

FIG. 55

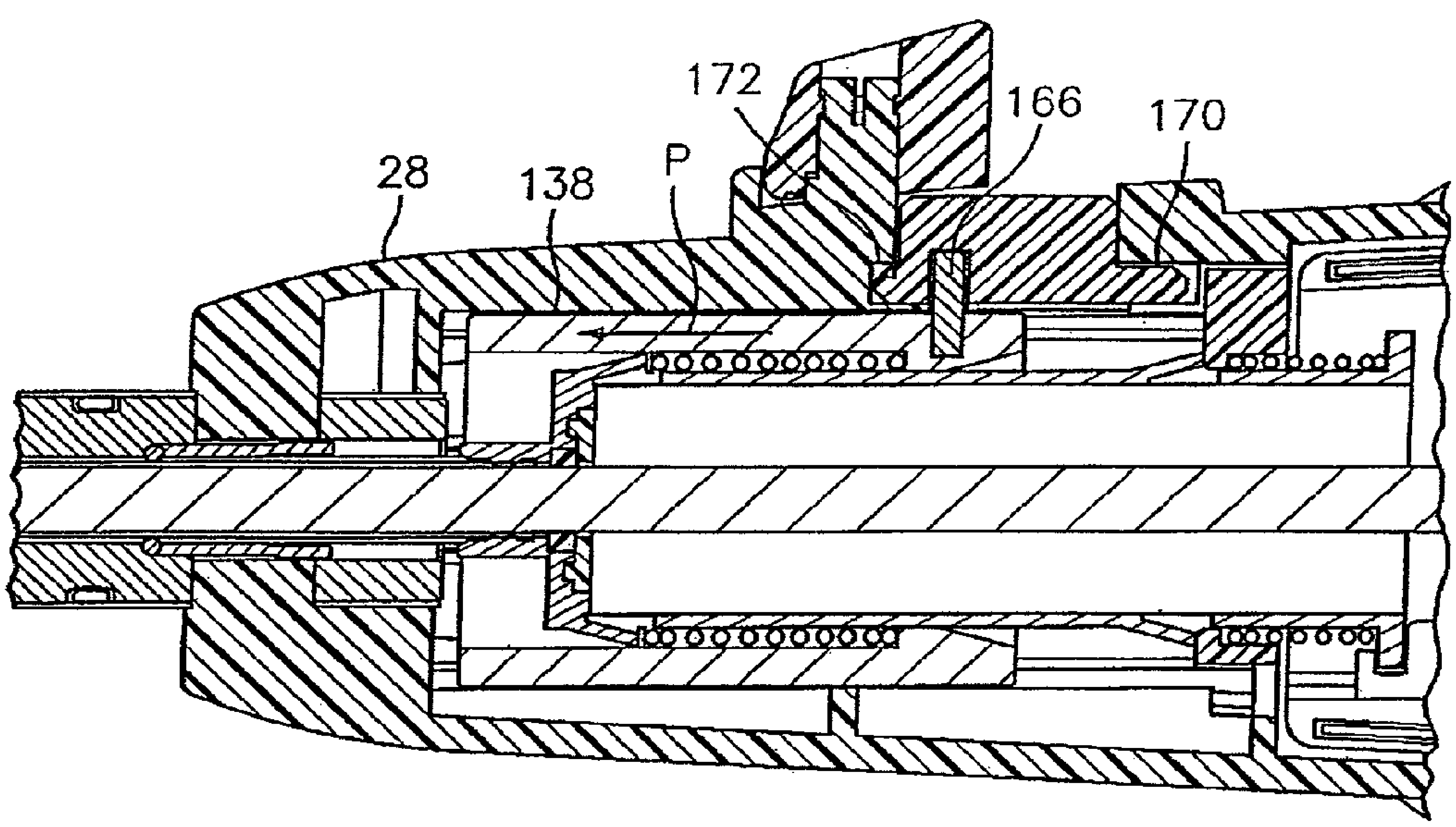

FIG. 56

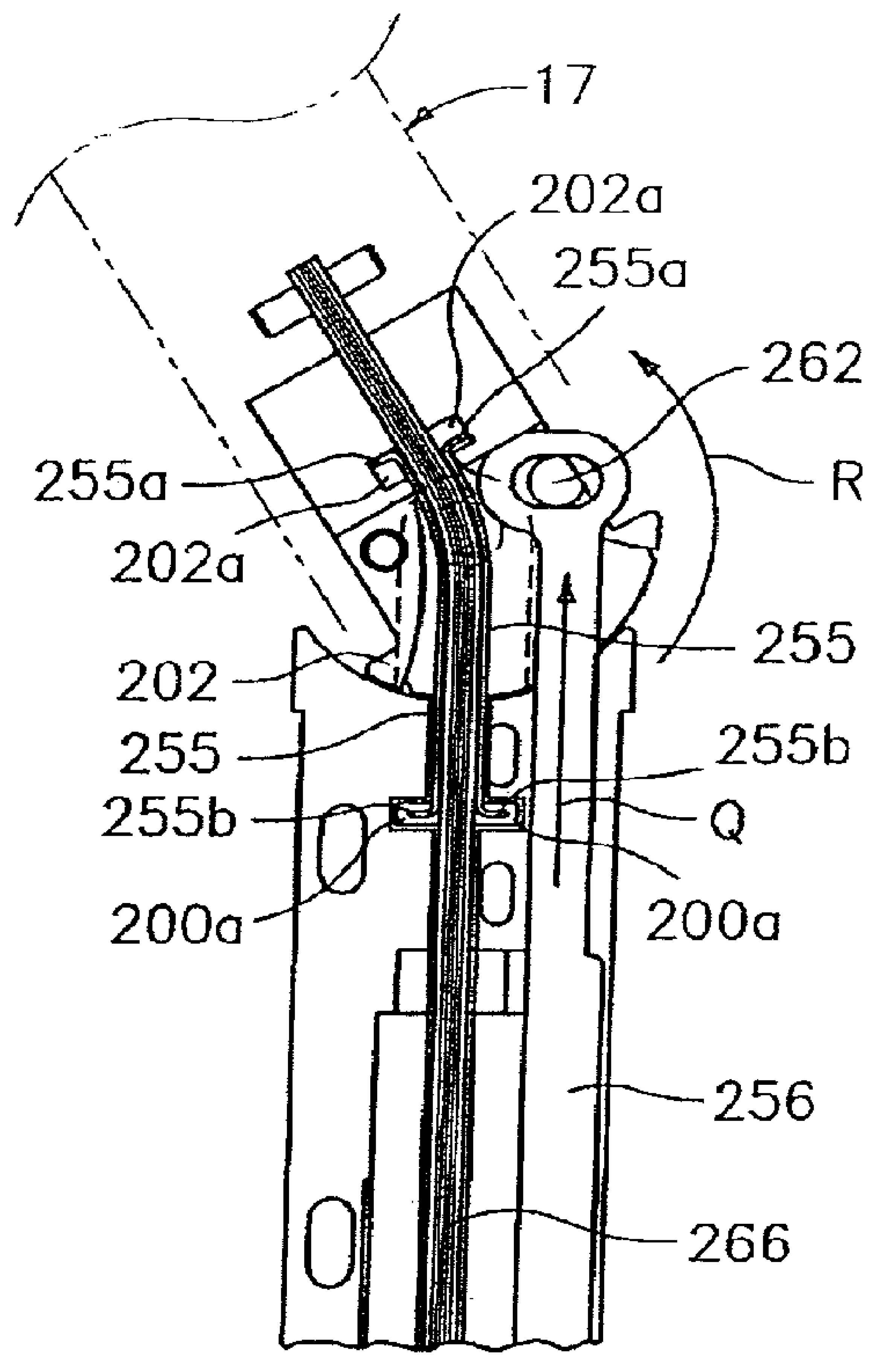

FIG. 57

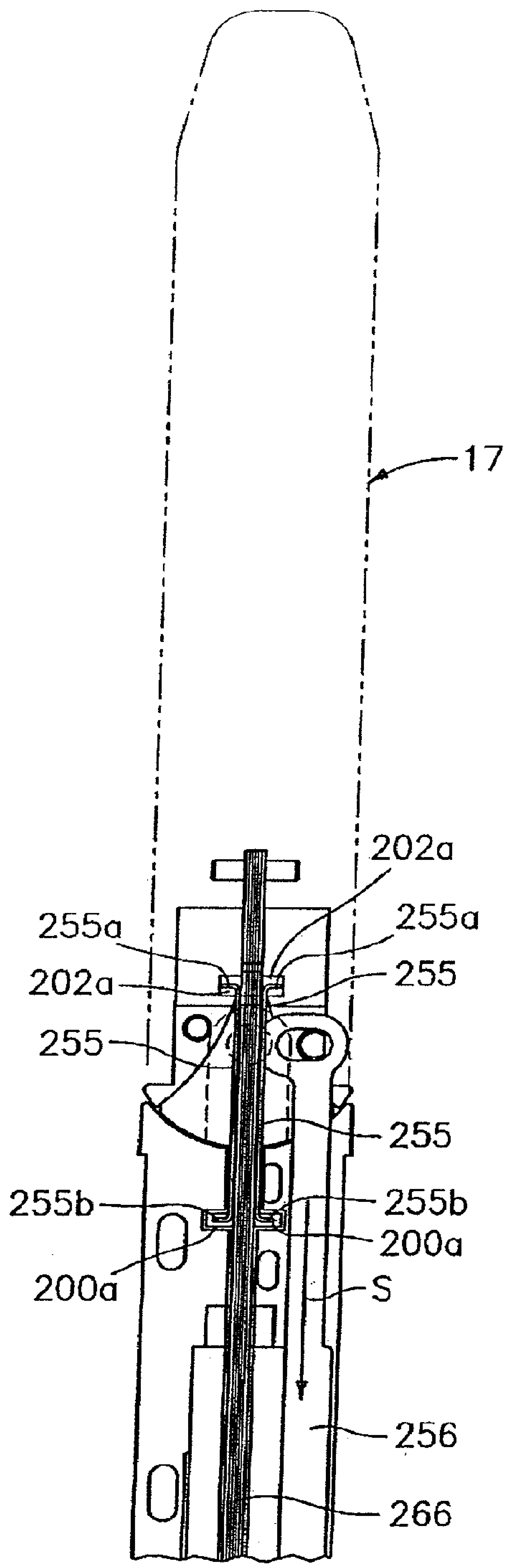

FIG. 60

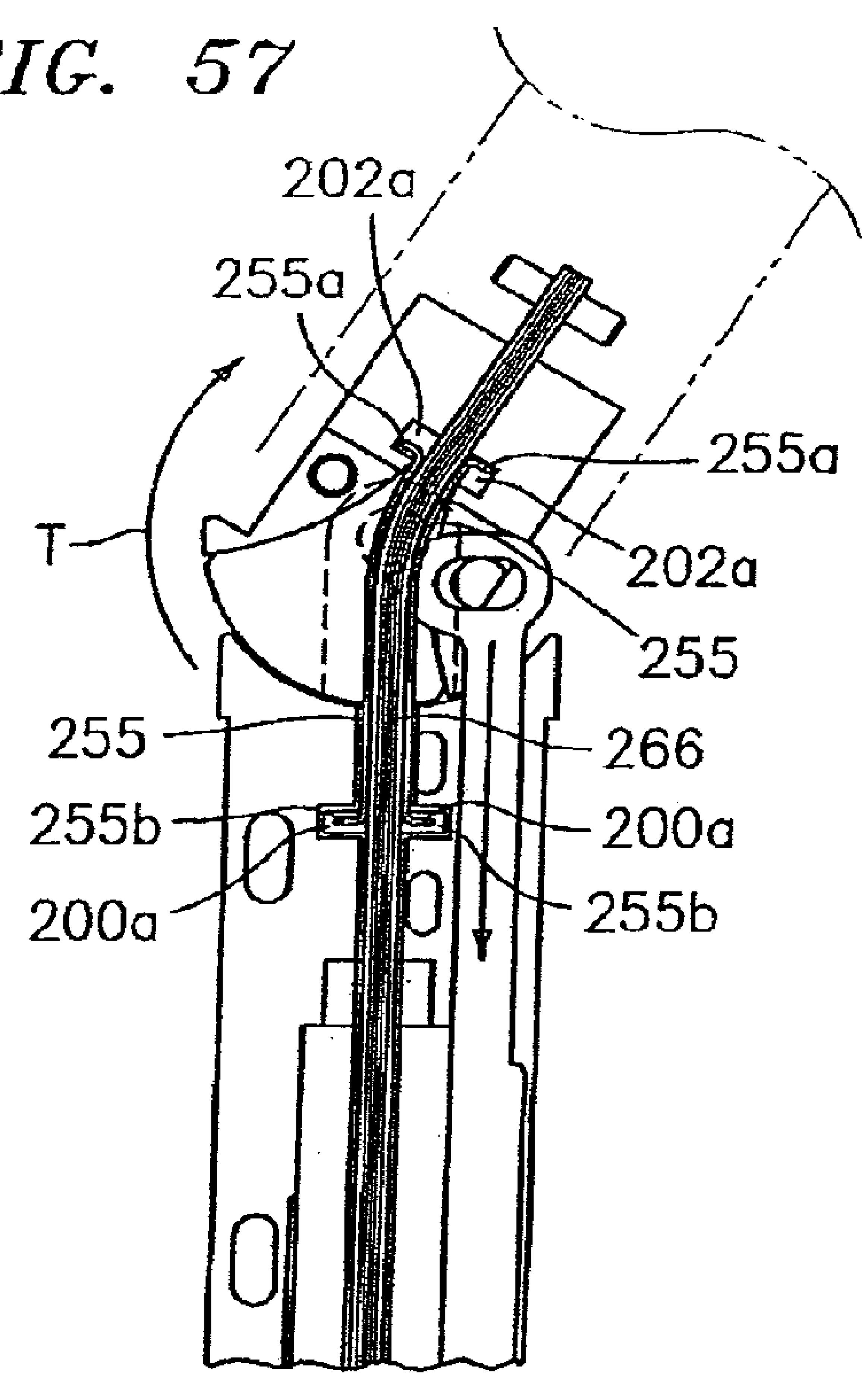

FIG. 61

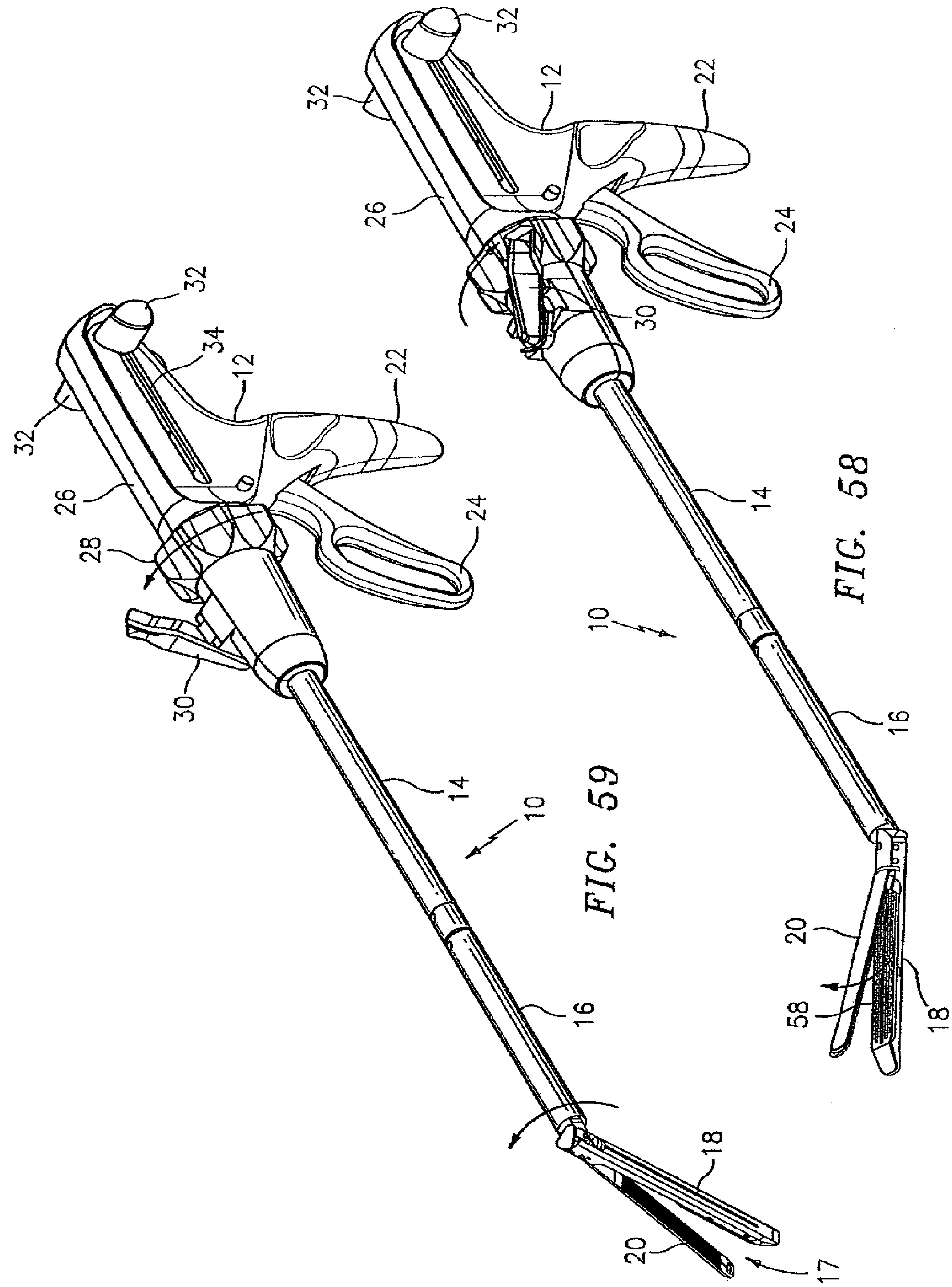
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FIG. 58

FIG. 59

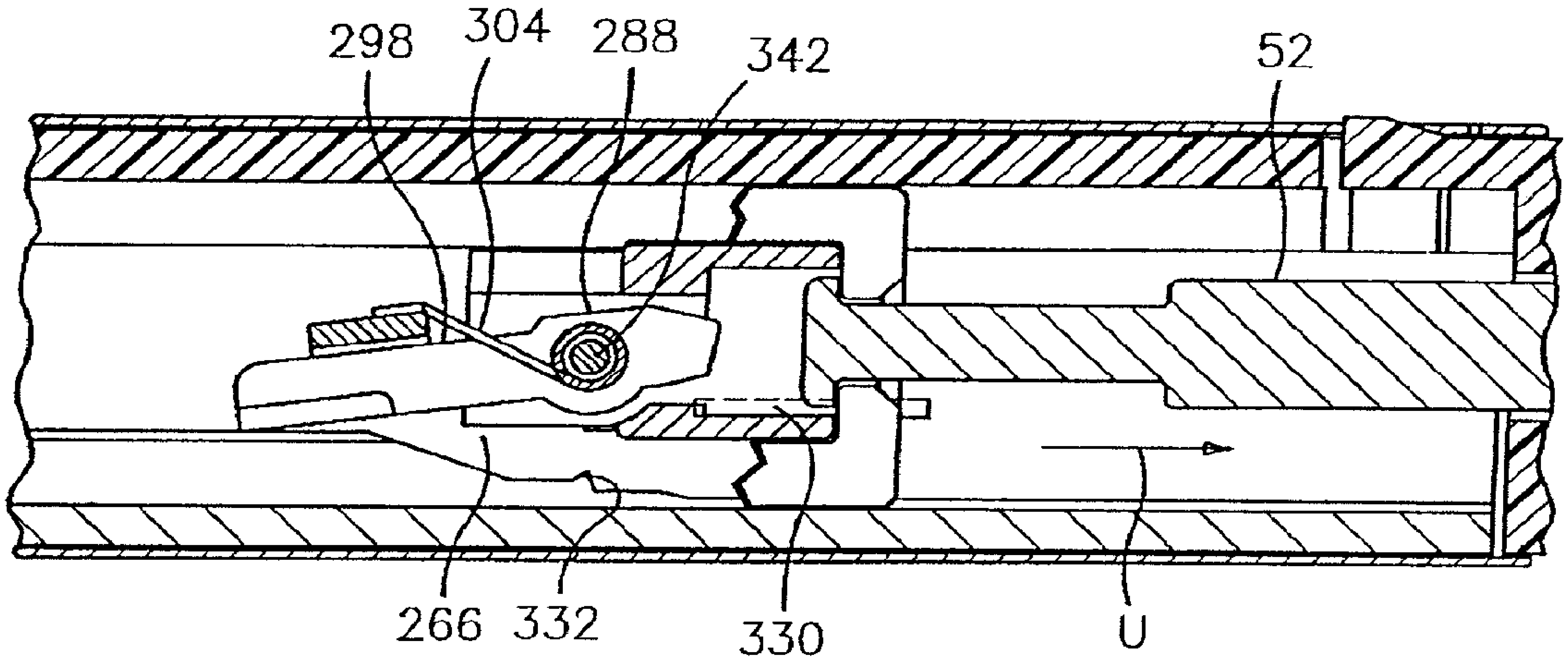

FIG. 62

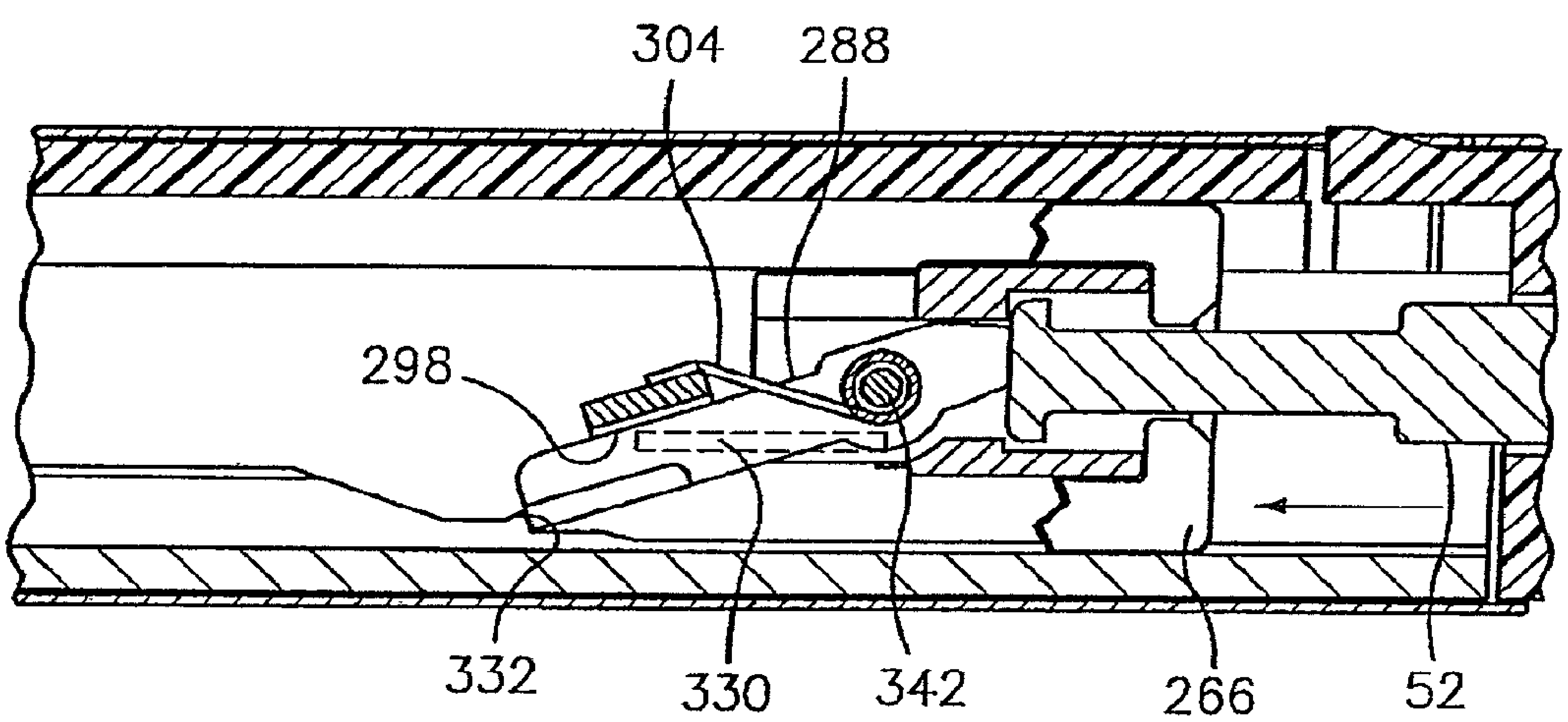

FIG. 63

SURGICAL STAPLING APPARATUS INCLUDING SENSING MECHANISM

CROSS-REFERENCE TO RELATED APPLICATIONS

This application is a continuation of U.S. patent application Ser. No. 13,585,350, filed on Aug. 14, 2012, now U.S. Pat. No. 8,342,377 which is a continuation of U.S. patent application Ser. No. 13/491,085, filed on Jun. 7, 2012, now U.S. Pat. No. 8,292,152, which is a continuation of U.S. patent application Ser. No. 13/295,140, filed on Nov. 14, 2011, now U.S. Pat. No. 8,256,656, which is a continuation of U.S. patent application Ser. No. 13/285,355, filed on Oct. 31, 2011, now U.S. Pat. No. 8,210,416, which is a continuation of U.S. patent application Ser. No. 12/793,196, filed on Jun. 3, 2010, now U.S. Pat. No. 8,070,033, which is a continuation of U.S. patent application Ser. No. 12/494,617, filed on Jun. 30, 2009, now U.S. Pat. No. 8,083,118, which is a divisional of U.S. patent application Ser. No. 11/974,638, filed on Oct. 15, 2007, now U.S. Pat. No. 7,565,993, which is a continuation of U.S. patent application Ser. No. 11/489,212, filed on Jul. 19, 2006, now U.S. Pat. No. 7,303,107, which is a continuation of U.S. patent application Ser. No. 11/186,742, filed on Jul. 20, 2005, now abandoned, which is a continuation of U.S. patent application Ser. No. 10/983,288, filed on Nov. 5, 2004, now U.S. Pat. No. 6,953,139, which is a continuation of U.S. patent application Ser. No. 10/700,250, filed on Nov. 3, 2003, now abandoned, which is a continuation of U.S. patent application Ser. No. 10/014,004, filed on Dec. 10, 2001, now U.S. Pat. No. 6,669,073, which is a continuation of U.S. patent application Ser. No. 09/680,093, filed on Oct. 5, 2000, now U.S. Pat. No. 6,330,965, which is a divisional of U.S. patent application Ser. No. 09/561,567, filed on Apr. 28, 2000, now U.S. Pat. No. 6,241,139, which is a divisional of U.S. patent application Ser. No. 09/166,378, filed on Oct. 5, 1998, now U.S. Pat. No. 6,079,606, which is a divisional of U.S. patent application Ser. No. 08/935,980, filed on Sep. 23, 1997, now U.S. Pat. No. 5,865,361. The entire content of each application identified above is hereby incorporated by reference.

BACKGROUND

1. Technical Field

This application relates to a surgical stapling apparatus, and more particularly, to an articulating mechanism for use with an endoscopic surgical stapling apparatus for sequentially applying a plurality of surgical fasteners to body tissue and optionally incising fastened tissue.

2. Background of Related Art

Surgical devices wherein tissue is first grasped or clamped between opposing jaw structure and then joined by surgical fasteners are well known in the art. In some instruments a knife is provided to cut the tissue which has been joined by the fasteners. The fasteners are typically in the form of surgical staples but two part polymeric fasteners can also be utilized.

Instruments for this purpose can include two elongated members which are respectively used to capture or clamp tissue. Typically, one of the members carries a staple cartridge which houses a plurality of staples arranged in at least two lateral rows while the other member has an anvil that defines a surface for forming the staple legs as the staples are driven from the staple cartridge. Generally, the stapling operation is effected by cam bars that travel longitudinally through the staple cartridge, with the cam bars acting upon staple pushers to sequentially eject the staples from the staple cartridge. A knife can travel between the staple rows to longitudinally cut

and/or open the stapled tissue between the rows of staples. Such instruments are disclosed, for example, in U.S. Pat. No. 3,079,606 and U.S. Pat. No. 3,490,675.

A later stapler disclosed in U.S. Pat. No. 3,499,591 applies a double row of staples on each side of the incision. This is accomplished by providing a disposable loading unit in which a cam member moves through an elongate guide path between two sets of staggered staple carrying grooves. Staple drive members are located within the grooves and are positioned in such a manner so as to be contacted by the longitudinally moving cam member to effect ejection of the staples from the staple cartridge of the disposable loading unit. Other examples of such staplers are disclosed in U.S. Pat. Nos. 4,429,695 and 5,065,929.

Each of the instruments described above were designed for use in conventional surgical procedures wherein surgeons have direct manual access to the operative site. However, in endoscopic or laparoscopic procedures, surgery is performed through a small incision or through a narrow cannula inserted through small entrance wounds in the skin. In order to address the specific needs of endoscopic and/or laparoscopic surgical procedures, endoscopic surgical stapling devices have been developed and are disclosed in, for example, U.S. Pat. Nos. 5,040,715 (Green, et al.); 5,307,976 (Olson, et al.); 5,312,023 (Green, et al.); 5,318,221 (Green, et al.); 5,326,013 (Green, et al.); and 5,332,142 (Robinson, et al.).

U.S. Surgical, the assignee of the present application, has manufactured and marketed endoscopic stapling instruments, such as the Multifire ENDO GIA* 30 and Multifire ENDO GIA* 60 instruments, for several years. These instruments have provided significant clinical benefits. Nonetheless, improvements are possible, for example, by reducing the cost and complexity of manufacture.

Current laparoscopic linear stapling devices are configured to operate with disposable loading units (U.S. Surgical) and staple cartridges (Ethicon) of only one size. For example, individual linear staplers are presently available for applying parallel rows of staples measuring 30 mm, 45 mm and 60 mm in length. Thus, during a normal operation, a surgeon may be required to utilize several different stapling instruments to perform a single laparoscopic surgical procedure. Such practices increase the time, complexity and overall costs associated with laparoscopic surgical procedures. In addition, costs are greater in designing and manufacturing multiple stapler sizes, as opposed to creating a single, multipurpose stapler.

It would be extremely beneficial to provide a surgical device for use during laparoscopic and/or endoscopic surgical procedures that can be employed with several different sized disposable loading units to reduce the overall costs associated with such procedures. It would also be particularly beneficial if the device could perform multiple tasks, using disposable loading units of varying size and of varying purpose, such as, for example, to staple, clip, cut and/or articulate.

In making improvements or modifications to the current instruments, it would be highly desirable not to sacrifice any of the important benefits of the MULTIFIRE ENDO GIA* 30 and 60 instruments as compared to other commercially available products, e.g., the endoscopic stapling instruments manufactured and marketed by Ethicon, Inc. For example, any improvement should advantageously provide a fresh knife blade for each firing of the instrument and ensure that the disposable loading unit is securely retained in the stapling instrument unless and until the operating team chooses to remove it. These advantages have historically been found in the U.S. Surgical instruments, but not in the Ethicon instruments.

SUMMARY

In accordance with the present disclosure, a surgical stapling apparatus for sequentially applying a plurality of fasteners to body tissue and simultaneously incising tissue is provided. The surgical stapling apparatus is adapted to receive disposable loading units having rows of staples having a linear length of between 30 mm and 60 mm. The surgical stapling apparatus is also adapted to receive articulating and non-articulating disposable loading units.

The surgical stapling apparatus includes a handle assembly having a movable handle and a stationary handle. The movable handle is movable through an actuation stroke to clamp tissue and to effect ejection of staples from the disposable loading unit. An elongated body extends distally from the handle assembly and defines a longitudinal axis. An actuation shaft having a toothed rack is operably associated with the movable handle by a pawl mechanism. The distal end of the actuation shaft is connected to a control rod having a distal end adapted to operatively engage an axial drive assembly located within a disposable loading unit.

The stapling apparatus includes an articulation mechanism having an articulation lever operatively engaged with a cam member having a stepped camming channel. The cam member is engaged with a translation member which includes a pin dimensioned to be received within the stepped camming channel such that pivotable movement of the lever causes linear movement of the translation member. A first articulation link includes a proximal end adapted to engage the translation member and a distal end adapted to engage a second articulation link positioned within the disposable loading unit. Linear movement of the translation member causes linear movement of the articulation links to cause articulation of a tool assembly of the disposable loading unit.

The surgical stapling apparatus also preferably includes a sensing mechanism for sensing the type of disposable loading unit secured to the elongated body of the apparatus. The sensing mechanism includes a sensing tube positioned within the elongated body to engage a disposable loading unit secured to the elongated body. A sensing cylinder connected to the sensing tube engages a locking ring having a tab portion configured to engage the articulation mechanism in a first position to prevent movement of the articulation lever. The locking ring is moved by the sensing cylinder when an articulating disposable loading unit is secured to the elongated body of the stapling apparatus to a second position to disengage the tab portion from the articulation mechanism to permit movement of the articulation lever. In contrast, a non-articulating disposable loading unit will not unlock the articulation lever.

BRIEF DESCRIPTION OF THE DRAWINGS

Various preferred embodiments are described herein with reference to the drawings:

FIG. **1** is a perspective view of one preferred embodiment of the presently disclosed surgical stapling apparatus;

FIG. **2** is a top view of the surgical apparatus shown in FIG. **1**;

FIG. **3** is a side view of the surgical apparatus shown in FIG. **1**;

FIG. **4** is a perspective view with parts separated of the handle assembly of the surgical apparatus shown in FIG. **1**;

FIG. **5** is a cross-sectional view of a portion of the firing lockout mechanism shown in FIG. **4**;

FIG. **6** is a perspective of the slide plate of the anti-reverse clutch mechanism of the surgical apparatus;

FIG. **7** is an enlarged perspective view of the anti-reverse clutch mechanism shown in FIG. **1**;

FIG. **8** is a side cross-sectional view of the surgical stapling apparatus shown in FIG. **1** in the non-actuated position with the disposable loading unit removed;

FIG. **9** is a perspective view with parts separated of the rotation member, the articulation mechanism, and the elongated body of the surgical stapling apparatus shown in FIG. **1**;

FIG. **10** is an enlarged view of the indicated area of detail shown in FIG. **8**;

FIG. **10***a* is a perspective view of the translation member of the articulating mechanism and the proximal end of the elongated body of the surgical stapling apparatus shown in FIG. **1**;

FIG. **10***b* is an enlarged cross-sectional view of the indicated area of detail of FIG. **8**;

FIG. **10***c* is a cross-sectional view along section line **10***c*-**10***c* of FIG. **8**;

FIG. **11** is a perspective view of the cam member of the articulation mechanism of the surgical stapling apparatus shown in FIG. **1**;

FIG. **12** is a top view of the cam member of the articulation mechanism of the surgical stapling apparatus shown in FIG. **1**;

FIG. **12***a* is a perspective view of a non-articulating disposable loading unit usable with the surgical stapling apparatus shown in FIG. **1**;

FIG. **12***b* is a perspective view of the preferred articulating disposable loading unit of the surgical stapling apparatus shown in FIG. **1**;

FIG. **13** is a cross-sectional view taken along section line **13-13** of FIG. **10**;

FIG. **14** is a cross-sectional view taken along section line **14-14** of FIG. **10**;

FIG. **15** is a cross-sectional view taken along section line **15-15** of FIG. **10**;

FIG. **16** is an enlarged view of the indicated area of detail shown in FIG. **8**;

FIG. **17** is a side perspective view of the blocking plate of the surgical stapling apparatus shown in FIG. **1**;

FIG. **18** is a top perspective view of the blocking plate of the surgical stapling apparatus shown in FIG. **1**;

FIG. **19** is a perspective view of a disposable loading unit usable with the surgical stapling apparatus of FIG. **1**;

FIG. **20** is another perspective view of a disposable loading unit usable with the surgical stapling apparatus of FIG. **1**;

FIG. **21** is a perspective view of the tool assembly of the surgical stapling apparatus of FIG. **1** with parts separated;

FIG. **22** is an enlarged perspective view of the distal end of the anvil assembly showing a plurality of staple deforming cavities;

FIG. **23** is an enlarged perspective view of the distal end of the staple cartridge of the surgical stapling apparatus shown in FIG. **1**;

FIG. **24** is a side cross-sectional view taken along section line **24-24** of FIG. **23**;

FIG. **25** is a bottom perspective view of the staple cartridge shown in FIG. **21**;

FIG. **26** is an enlarged perspective view of the actuation sled, the pushers and the fasteners shown in FIG. **21**;

FIG. **27** is an enlarged perspective view with parts separated of the proximal housing portion and mounting assembly of the disposable loading unit shown in FIG. **19**;

FIG. **28** is an enlarged perspective view of the mounting assembly of the disposable loading unit shown in FIG. **19** mounted to a distal end portion of the proximal housing portion;

FIG. **29** is an enlarged perspective view of the proximal housing portion and the mounting assembly of the disposable loading unit shown in FIG. **19** with the upper housing half removed;

FIG. **30** is a perspective view of the proximal housing portion and the mounting assembly of the disposable loading unit shown in FIG. **19** with the upper housing half removed;

FIG. **31** is a perspective view with parts separated of the axial drive assembly;

FIG. **32** is an enlarged perspective view of the axial drive assembly shown in FIG. **31**;

FIG. **33** is an enlarged perspective view of the proximal end of the axial drive assembly shown in FIG. **31** including the locking device;

FIG. **34** is an enlarged perspective view of the distal end of the axial drive assembly shown in FIG. **31**;

FIG. **35** is an enlarged perspective view of the distal end of the elongated body of the stapling apparatus shown in FIG. **1**;

FIG. **36** is an enlarged perspective view of the locking device shown in FIG. **33**;

FIG. **37** is an enlarged perspective view of a lower housing half of the proximal housing portion of the disposable loading unit shown in FIG. **27**;

FIG. **38** is a side cross-sectional view of the disposable loading unit shown in FIG. **20**;

FIG. **39** is an enlarged view of the indicated area of detail shown in FIG. **38**;

FIG. **40** is a perspective view of the surgical stapling apparatus shown in FIG. **1** with the disposable loading unit of FIG. **19** detached from the elongated body;

FIG. **41** is an enlarged perspective view of the disposable loading unit of FIG. **19** during attachment to the elongated body of the surgical stapling apparatus shown in FIG. **1**;

FIG. **42** is another enlarged perspective view of the disposable loading unit of FIG. **19** during attachment to the elongated body of the surgical stapling apparatus shown in FIG. **1**;

FIG. **43** is a cross-sectional view taken along section line **43-43** of FIG. **41**;

FIG. **43***a* is a side cross-sectional view of the rotation knob, articulation mechanism, and sensing mechanism during insertion of a disposable loading unit into the elongated body of the surgical stapling apparatus;

FIG. **44** is a cross-sectional view taken along section line **44-44** of FIG. **42**;

FIG. **45** is a side cross-sectional view of the distal end of the disposable loading unit of FIG. **1** with tissue positioned between the anvil and clamp assemblies;

FIG. **46** is a side cross-sectional view of the handle assembly with the movable handle in an actuated position;

FIG. **47** is an enlarged view of the indicated area of detail shown in FIG. **46**;

FIG. **48** is a cross-sectional view of the proximal end of the disposable loading unit of FIG. **19** and the distal end of the elongated body of the surgical stapling apparatus shown in FIG. **1** with the control rod in a partially advanced position;

FIG. **49** is a cross-sectional view of the tool assembly of the surgical stapling apparatus shown in FIG. **1** positioned about tissue in the clamped position;

FIG. **50** is a cross-sectional view of the handle assembly of the stapling apparatus of FIG. **1** during the clamping stroke of the apparatus;

FIG. **51** is a side cross-sectional view of the distal end of the tool assembly of the stapling apparatus shown in FIG. **1** during firing of the apparatus;

FIG. **52** is a side cross-sectional view of the distal end of the tool assembly of the stapling apparatus shown in FIG. **1** after firing of the apparatus;

FIG. **53** is a side cross-sectional view of the handle assembly of the apparatus during retraction of the actuation shaft;

FIG. **54** is a side cross-sectional view of the handle assembly of the stapling apparatus during actuation of the emergency release button;

FIG. **55** is a top view of the articulation mechanism of the surgical stapling apparatus;

FIG. **56** is a side cross-sectional view of the articulation mechanism and rotation member of the surgical stapling apparatus shown in FIG. **1**;

FIG. **57** is a top view of the distal end of the elongated body, the mounting assembly, and the proximal end of the tool assembly during articulation of the stapling apparatus;

FIG. **58** is a perspective view of the surgical stapling apparatus during articulation of the tool assembly;

FIG. **59** is a perspective view of the surgical stapling apparatus during articulation and rotation of the tool assembly;

FIG. **60** is a top view of the distal end of the disposable loading unit immediately prior to articulation;

FIG. **61** is a top view of the distal end of the elongated body, the mounting assembly, and the proximal end of the tool assembly during articulation of the stapling apparatus;

FIG. **62** is a partial cross-sectional view of a portion of the disposable loading unit during retraction of the locking device; and

FIG. **63** is a partial cross-sectional view of a portion of the disposable loading unit with the locking device in the locked position.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

Preferred embodiments of the presently disclosed endoscopic surgical stapling apparatus will now be described in detail with reference to the drawings, in which like reference numerals designate identical or corresponding elements in each of the several views.

In the drawings and in the description that follows, the term "proximal", as is traditional, will refer to the end of the stapling apparatus which is closest to the operator, while the term distal will refer to the end of the apparatus which is furthest from the operator.

FIGS. **1-3** illustrate one embodiment of the presently disclosed surgical stapling apparatus shown generally as **10**. Briefly, surgical stapling apparatus **10** includes a handle assembly **12** and an elongated body **14**. A disposable loading unit or DLU **16** is releasably secured to a distal end of elongated body **14**. Disposable loading unit **16** includes a tool assembly **17** having a cartridge assembly **18** housing a plurality of surgical staples and an anvil assembly **20** movably secured in relation to cartridge assembly **18**. Disposable loading unit **16** is configured to apply linear rows of staples measuring from about 30 mm to about 60 mm in length. Disposable loading units having linear rows of staples of other lengths are also envisioned, e.g., 45 mm. Handle assembly **12** includes a stationary handle member **22**, a movable handle member **24**, and a barrel portion **26**. A rotatable member **28** is preferably mounted on the forward end of barrel portion **26** to facilitate rotation of elongated body **14** with respect to handle assembly **12**. An articulation lever **30** is also preferably mounted on the forward end of barrel portion **26** adjacent rotatable knob **28** to facilitate articulation of tool assembly **17**. A pair of retraction knobs **32** are movably positioned along barrel portion **26** to return surgical stapling apparatus **10** to a retracted position, as will be described in detail below.

Referring to FIG. **4**, handle assembly **12** includes housing **36**, which is preferably formed from molded housing half-sections **36***a* and **36***b*, which forms stationary handle member **22** and barrel portion **26** of handle assembly **12** (See FIG. **1**). Movable handle member **24** is pivotably supported between housing half-sections **36***a* and **36***b* about pivot pin **38**. A biasing member **40**, which is preferably a torsion spring, biases movable handle **24** away from stationary handle **22**. An actuation shaft **46** is supported within barrel portion **26** of housing **36** and includes a toothed rack **48**. A driving pawl **42** having a rack engagement finger **43** with laterally extending wings **43***a* and **43***b* is pivotably mounted to one end of movable handle **24** about a pivot pin **44**. A biasing member **50**, which is also preferably a torsion spring, is positioned to urge engagement finger **43** of driving pawl **42** towards toothed rack **48** of actuation shaft **46**. Movable handle **24** is pivotable to move engagement finger **43** of driving pawl **42** into contact with toothed rack **48** of actuation shaft **46** to advance the actuation shaft linearly in the distal direction. The forward end of actuation shaft **46** rotatably receives the proximal end **49** of a control rod **52** such that linear advancement of actuation shaft **46** causes corresponding linear advancement of control rod **52**. A locking pawl **54** having a rack engagement member **55** is pivotably mounted within housing **36** about pivot pin **57** and is biased towards toothed rack **48** by biasing member **56**, which is also preferably a torsion spring. Engagement member **55** of locking pawl **54** is movable into engagement with toothed rack **48** to retain actuation shaft **46** in a longitudinally fixed position.

A retraction mechanism **58** which includes a pair of retractor knobs **32** (See FIG. **1**) is connected to the proximal end of actuation shaft **46** by a coupling rod **60**. Coupling rod **60** includes right and left engagement portions **62***a* and **62***b* for receiving retractor knobs **32** and a central portion **62***c* which is dimensioned and configured to translate within a pair of longitudinal slots **34***a* formed in actuation shaft **46** adjacent the proximal end thereof. A release plate **64** is operatively associated with actuation shaft **46** and is mounted for movement with respect thereto in response to manipulation of retractor knobs **32**. A pair of spaced apart pins **66** extend outwardly from a lateral face of actuation shaft **46** to engage a pair of corresponding angled cam slots **68** formed in release plate **64**. Upon rearward movement of retractor knobs **32**, pins **66** can release plate **64** downwardly with respect to actuation shaft **46** and with respect to toothed rack **48** such that the bottom portion of release plate **64** extends below toothed rack **48** to disengage engagement finger **43** of driving pawl **42** from toothed rack **48**. A transverse slot **70** is formed at the proximal end of release plate **64** to accommodate the central portion **62***c* of coupling rod **60**, and elongated slots **34** (See FIG. **1**) are defined in the barrel section **26** of handle assembly **12** to accommodate the longitudinal translation of coupling rod **60** as retraction knobs **32** are pulled rearwardly to retract actuation shaft **46** and thus retract control rod **52** rearwardly. Actuation shaft **46** is biased proximally by spring **72** which is secured at one end to coupling rod portion **62** via connector **74** and at the other end to post **76** on actuation shaft **46**.

Referring also to FIG. **5**, handle assembly **12** includes a firing lockout assembly **80** which includes a plunger **82** and a pivotable locking member **83**. Plunger **82** is biased to a central position by biasing springs **84** and includes, annular tapered camming surfaces **85**. Each end of plunger **82** extends through housing **36** (See FIG. **1**) adjacent an upper end of stationary handle **22**. Pivotable locking member **83** is pivotably attached at its distal end between housing half-sections **36***a* and **36***b* about pivot pin **86** and includes a locking surface **88** and proximal extension **90** having a slot **89** formed therein. Locking member **83** is biased by spring **92** counter-clockwise (as viewed in FIG. **4**) to move locking surface **88** to a position to abut the distal end of actuation shaft **46** to prevent advancement of shaft **46** and subsequent firing of stapling apparatus **10**. Annular tapered camming surface **85** is positioned to extend into tapered slot **89** in proximal extension **90**. Lateral movement of plunger **82** in either direction against the bias of either spring **84** moves tapered camming surface **85** into engagement with the sidewalls of tapered slot **89** to pivot locking member **83** clockwise about pivot pin **86**, as viewed in FIG. **4**, to move blocking surface **88** to a position to permit advancement of actuation shaft **46** and thus firing of stapling apparatus **10**. Blocking surface **88** is retained in this position by recesses **87** which receive the tapered tip of camming surface **85** to lock locking member **83** in a counter-clockwise position. Operation of firing lockout assembly **80** will be further illustrated below.

Referring to FIGS. **4**, **6**, and **7**, handle mechanism **12** also includes an anti-reverse clutch mechanism which includes a first gear **94** rotatably mounted on a first shaft **96**, and second gear **98** mounted on a second shaft **100**, and a slide plate **102** (FIGS. **6** and **7**) slidably mounted within housing **36**. Slide plate **102** includes an elongated slot **104** dimensioned and configured to be slidably positioned about locking pawl pivot pin **57**, a gear plate **106** configured to mesh with the teeth of second gear **98**, and a cam surface **108**. In the retracted position, cam surface **108** of slide plate **102** engages locking pawl **54** to prevent locking pawl **54** from engaging toothed rack **48**. Actuation shaft **46** includes a distal set of gear teeth **110***a* spaced from a proximal set of gear teeth **110***b* positioned to engage first gear **94** of actuation shaft **46** during movement of actuation shaft **46**. When actuation shaft **46** is advanced by pivoting movable handle **24** about pivot pin **38**, distal gear teeth **110***a* on actuation shaft **46** mesh with and rotate first gear **94** and first shaft **96**. First shaft **96** is connected to second shaft **100** by spring clutch assembly such that rotation of first shaft **96** will cause corresponding rotation of second shaft **100**. Rotation of second shaft **100** causes corresponding rotation of second gear **98** which is engaged with gear plate **106** on slide plate **102** to cause linear advancement of slide plate **102**. Linear advancement of slide plate **102** is limited to the length of elongated slot **104**. When slide plate has been advanced the length of slot **104**, cam surface **108** releases locking pawl **54** such that it is moved into engagement with toothed rack **48**. Continued advancement of actuation shaft **46** eventually moves gear teeth **110***b* into engagement with gear plate **106**. However, since slide plate **102** is longitudinally fixed in position, the spring clutch is forced to release, such that continued distal advancement of actuation shaft **46** is permitted.

When actuation shaft **46** is returned to the refracted position (by pulling retraction knobs **34** proximally, as discussed above) gear teeth **110***b* engage first gear **94** to rotate second gear **98** in the reverse direction to retract slide member **102** proximally within housing **36**. Proximal movement of slide member **102** advances cam surface **108** into locking pawl **54** prior to engagement between locking pawl **54** and toothed rack **48** to urge locking pawl **54** to a position to permit retraction of actuation shaft **46**.

Referring again to FIG. **4**, handle assembly **12** includes an emergency return button **112** pivotally mounted within housing **36** about a pivot member **114** supported between housing half-sections **36***a* and **36***b*. Return button **112** includes an externally positioned member **116** positioned on the proximal end of barrel portion **26**. Member **116** is movable about pivot member **114** into engagement with the proximal end of locking pawl **54** to urge rack engagement member **55** out of engagement with toothed rack **48** to permit retraction of actuation shaft **46** during the firing stroke of the stapling apparatus **10**. As discussed above, during the clamping portion of advancement of actuation shaft **46**, slide plate **102** disengages pawl **54** from rack **48** and thus actuation of return button **112** is not necessary to retract the actuation shaft **46**.

FIG. **8** illustrates the interconnection of elongated body **14** and handle assembly **12**. Referring to FIGS. **8-10**, housing **36** includes an annular channel **117** configured to receive an annular rib **118** formed on the proximal end of rotation member **28**, which is preferably formed from molded half-sections **28***a* and **28***b* Annular channel **117** and rib **118** permit relative rotation between rotation member **28** and housing **36**. Elongated body **14** includes inner housing **122** and an outer casing **124**. Inner housing **122** is dimensioned to be received within outer casing **124** and includes an internal bore **126** (FIG. **8**) which extends therethrough and is dimensioned to slidably receive a first articulation link **123** and control rod **52**. The proximal end of housing **122** and casing **124** each include a pair of diametrically opposed openings **130** and **128**, respectively, which are dimensioned to receive radial projections **132** formed on the distal end of rotation member **28**. Projections **132** and openings **128** and **130** fixedly secure rotation member **28** and elongated body **14** in relation to each other, both longitudinally and rotatably. Rotation of rotation knob **28** with respect to handle assembly **12** thus results in corresponding rotation of elongated body **14** with respect to handle assembly **12**.

An articulation mechanism **120** is supported on rotatable member **28** and includes articulation lever **30**, a cam member **136**, a translation member **138**, and first articulation link **123** (FIG. **9**). Articulation lever **30** is pivotably mounted about pivot member **140** which extends outwardly from rotation member **28** and is preferably formed integrally therewith. A projection **142** extends downwardly from articulation lever **30** for engagement with cam member **136**.

Referring temporarily to FIGS. **11** and **12**, cam member **136** includes a housing **144** having an elongated slot **146** extending through one side thereof and a stepped camming surface **148** formed in the other side thereof. Each step of camming surface **148** corresponds to a particular degree of articulation of stapling apparatus **10**. Although five steps are illustrated, fewer or more steps may be provided. Elongated slot **146** is configured to receive projection **142** formed on articulation lever **30**. Housing **144** includes a distal stepped portion **150** and a proximal stepped portion **152**. Proximal stepped portion **152** includes a recess **154**.

Referring again to FIGS. **8-10** and also to FIGS. **13-15**, translation member **138** includes a plurality of ridges **156** which are configured to be slidably received within grooves **158** formed along the inner walls of rotation member **28**. Engagement between ridges **156** and grooves **158** prevent relative rotation of rotation member **28** and translation member **138** while permitting relative linear movement. The distal end of translation member **138** includes arm **160** which includes an opening **162** configured to receive a finger **164** extending from the proximal end of articulation link **123** (See FIG. **10***a*). A pin **166** having a housing **168** constructed from a non-abrasive material, e.g., teflon, is secured to translation member **138** and dimensioned to be received within stepped camming surface **148**.

In an assembled condition, proximal and distal stepped portions **150** and **152** of cam member **136** are positioned beneath flanges **170** and **172** formed on rotation member **28** to restrict cam member **136** to transverse movement with respect to the longitudinal axis of stapling apparatus **10**. When articulation lever **30** is pivoted about pivot member **140**, cam member **136** is moved transversely on rotation member **28** to move stepped camming surface **148** transversely relative to pin **166**, forcing pin **166** to move proximally or distally along stepped cam surface **148**. Since pin **166** is fixedly attached to translation member **138**, translation member **138** is moved proximally or distally to effect corresponding proximal or distal movement of first actuation link **123**.

Referring to FIGS. **8-10** and **16**, a disposable loading unit sensing mechanism extends within stapling apparatus **10** from elongated body **14** into handle assembly **12**. The sensing mechanism includes a sensor tube **176** which is slidably supported within bore **26** of elongated body **14**. The distal end of sensor tube **176** is positioned towards the distal end of elongated body **14** and the proximal end of sensor tube **176** is secured within the distal end of a sensor cylinder **176** via a pair of nubs **180**. The distal end of a sensor link **182** is secured to the proximal end of sensor cylinder **178**. Sensor link **182** (See FIGS. **8***a* and **8***c*) has a bulbous end **184** which engages a camming surface **83***a* on pivotable locking member **83**. When a disposable loading unit (not shown) is inserted in the distal end of elongated body **14**, the disposable loading unit engages the distal end **177** of sensor tube **176** to drive sensor tube **176** proximally, and thereby drive sensor cylinder **178** and sensor link **182** proximally. Movement of sensor link **182** proximally causes bulbous end **184** of sensor link **182** to move distally of camming surface **83***a* to allow locking member **83** to pivot under the bias of spring **92** from a position permitting firing of stapling apparatus **10** to a blocking position, wherein blocking member **83** is positioned to engage actuation shaft **46** and prevent firing of stapling apparatus **10**. Sensor link **182** and locking member **83** function to prevent firing of surgical stapling apparatus **10** after a disposable loading unit has been secured to elongated body **14**, without first operating firing lockout assembly **80**. It is noted that movement of link **182** proximally permits locking member **83** to move to its position shown in FIG. **5**.

Referring again to FIGS. **9-12**, cam member **136** includes recess **154**. A locking ring **184** having a nub portion **186** configured to be received within recess **154** is positioned about sensor cylinder **178** between a control tab portion **188** and a proximal flange portion **190**. A spring **192** positioned between flange portion **190** and locking ring **184** urges locking ring distally about sensor cylinder **178**. When an articulating disposable loading unit **16***b* having an extended insertion tip **193** is inserted into the distal end of elongated body **14** of stapling apparatus **10**, insertion tip **193** causes tab portion **188** to move proximally into engagement with locking ring **184** to urge locking ring **184** and nub **186** proximally of recess **154** in cam member **136** (See FIG. **12***b*). With nub **186** positioned proximally of recess **154**, cam member **136** is free to move transversely to effect articulation of stapling apparatus **10**. A non-articulating disposable loading unit does not have an extended insertion tip (See FIG. **12***a*). As such, when a non-articulating disposable loading unit is inserted in elongated body **14**, sensor cylinder **178** is not retracted proximally a sufficient distance to move nub **186** from recess **154**. Thus, cam member **136** is prevented from moving transversely by nub **186** of locking ring **184** which is positioned in recess **154** and articulation lever **30** is locked in its central position.

Referring to FIGS. **16-18**, the distal end of elongated body **14** includes a control rod locking mechanism **190** which is activated during insertion of a disposable loading unit into elongated body **14**. Control rod locking mechanism **190** includes a blocking plate **192** which is biased distally by a spring **194** and includes a proximal finger **189** having angled cam surface **195**. A semi-circular engagement member **196** is biased transversely towards control rod **52** by a spring **197**. Control rod **52** includes an annular recess **199** configured to receive engagement member **196**. Blocking plate **192** is movable from a distal position spaced from engagement member **196** to a proximal position located behind engagement member **196**. In the proximal position, engagement member **196** is prevented from being biased from recess **199** by engagement with blocking plate **192**. During insertion of a disposable loading unit **16** (See FIG. **1**) into the distal end of elongated body **14**, as will be described in further detail below, cam surface **195** of blocking plate **192** is engaged by a nub **254** (FIG. **30**) on the disposable loading unit **16** as the disposable loading unit is rotated into engagement with elongated body **14** to urge plate **192** to the proximal position. Engagement member **196**, which is positioned within recess **199**, is retained therein by blocking plate **192** while nub **254** engages cam surface **195** to prevent longitudinal movement of control rod **52** during assembly. When the disposable loading unit **16** is properly positioned with respect to the elongated body **14**, nub **254** on the proximal end of the disposable loading unit **16** passes off cam surface **195** allowing spring **194** to return blocking plate **192** to its distal position to permit subsequent longitudinal movement of control rod **52**. It is noted that when the disposable loading unit nub passes off cam surface **195**, an audible clicking sound is produced indicating that the disposable loading unit **16** is properly fastened to the elongated body **14**.

Referring to FIGS. **19** and **20**, disposable loading unit **16** includes a proximal housing portion **200** adapted to releasably engage the distal end of body portion **14** (FIG. **1**). A mounting assembly **202** is pivotally secured to the distal end of housing portion **200**, and is configured to receive the proximal end of tool assembly **17** such that pivotal movement of mounting assembly **202** about an axis perpendicular to the longitudinal axis of housing portion **200** effects articulation of tool assembly **17**.

Referring to FIGS. **21-26**, tool assembly **17** preferably includes anvil assembly **20** and cartridge assembly **18**. Anvil assembly **20** includes anvil portion **204** having a plurality of staple deforming concavities **206** (FIG. **22**) and a cover plate **208** secured to a top surface of anvil portion **204** to define a cavity **210** (FIG. **24**) therebetween. Cover plate **208** is provided to prevent pinching of tissue during clamping and firing of stapling apparatus **10**. Cavity **210** is dimensioned to receive a distal end of an axial drive assembly **212** (See FIG. **27**). A longitudinal slot **214** extends through anvil portion **204** to facilitate passage of retention flange **284** of axial drive assembly **212** into the anvil cavity **210**. A camming surface **209** formed on anvil portion **204** is positioned to engage axial drive assembly **212** to facilitate clamping of tissue **198**. A pair of pivot members **211** formed on anvil portion **204** are positioned within slots **213** formed in carrier **216** to guide the anvil portion between the open and clamped positions. A pair of stabilizing members **215** engage a respective shoulder **217** formed on carrier **216** to prevent anvil portion **204** from sliding axially relative to staple cartridge **220** as camming surface **209** is deformed.

Cartridge assembly **18** includes a carrier **216** which defines an elongated support channel **218**. Elongated support channel **218** is dimensioned and configured to receive a staple cartridge **220**. Corresponding tabs **222** and slots **224** formed along staple cartridge **220** and elongated support channel **218** function to retain staple cartridge **220** within support channel **218**. A pair of support struts **223** formed on staple cartridge **220** are positioned to rest on side walls of carrier **216** to further stabilize staple cartridge **220** within support channel **218**.

Staple cartridge **220** includes retention slots **225** for receiving a plurality of fasteners **226** and pushers **228**. A plurality of spaced apart longitudinal slots **230** extend through staple cartridge **220** to accommodate upstanding cam wedges **232** of actuation sled **234**. A central longitudinal slot **282** extends along the length of staple cartridge **220** to facilitate passage of a knife blade **280**. During operation of surgical stapler **10**, actuation sled **234** translates through longitudinal slots **230** of staple cartridge **220** to advance cam wedges **232** into sequential contact with pushers **228**, to cause pushers **228** to translate vertically within slots **224** and urge fasteners **226** from slots **224** into the staple deforming cavities **206** of anvil assembly **20**.

Referring to FIGS. **27** and **28**, mounting assembly **202** includes upper and lower mounting portions **236** and **238**. Each mounting portion includes a threaded bore **240** on each side thereof dimensioned to receive threaded bolts **242** (See FIG. **21**) for securing the proximal end of carrier **216** thereto. A pair of centrally located pivot members **244** (See FIG. **21**) extends between upper and lower mounting portions via a pair of coupling members **246** which engage the distal end of housing portion **200**. Coupling members **246** each include an interlocking proximal portion **248** configured to be received in grooves **250** formed in the proximal end of housing portion **200** to retain mounting assembly **202** and housing portion **200** in a longitudinally fixed position in relation thereto.

Housing portion **200** of disposable loading unit **16** includes an upper housing half **250** and a lower housing half **252** contained within an outer casing **251**. The proximal end of housing half **250** includes engagement nubs **254** for releasably engaging elongated body **14** and an insertion tip **193**. Nubs **254** form a bayonet type coupling with the distal end of body **14** which will be discussed in further detail below. Housing halves **250** and **252** define a channel **253** for slidably receiving axial drive assembly **212**. A second articulation link **256** is dimensioned to be slidably positioned within a slot **258** formed between housing halves **250** and **252**. A pair of blow out plates **255** are positioned adjacent the distal end of housing portion **200** adjacent the distal end of axial drive assembly **212** to prevent outward bulging of drive assembly **212** during articulation of tool assembly **17**. Each blow-out plate **255**, as illustrated in FIGS. **27**, **57**, **60** and **61**, includes a planar surface which is substantially parallel to the pivot axis of tool assembly **17** and is positioned on a side of drive assembly **212** and the pivot axis to prevent outward bulging of drive assembly **212**. Each blow-out plate includes a first distal bend **255*a*** which is positioned in a respective first groove **202*a*** formed in mounting assembly **202** and a second proximal bend **255*b*** which is positioned in a respective second groove **200*a*** formed in a distal end of housing portion **200**.

Referring to FIGS. **29-30**, second articulation link **256** includes at least one elongated metallic plate. Preferably, two or more metallic plates are stacked to form link **256**. The proximal end of articulation link **256** includes a hook portion **258** configured to engage first articulation link **123** (See FIG. **9**) and the distal end includes a loop **260** dimensioned to engage a projection **262** formed on mounting assembly **202**. Projection **262** is laterally offset from pivot pin **244** such that linear movement of second articulation link **256** causes mounting assembly **202** to pivot about pivot pins **244** to articulate tool assembly **17**.

Referring also to FIGS. **31-34**, axial drive assembly **212** includes an elongated drive beam **266** including a distal working head **268** and a proximal engagement section **270**. Drive beam **266** may be constructed from a single sheet of material or, preferably, multiple stacked sheets. Engagement section **270** includes a pair of engagement fingers **270***a* and **270***b* which are dimensioned and configured to mountingly engage a pair of corresponding retention slots **272***a* and **272***b* formed in drive member **272**. Drive member **272** includes a proximal porthole **274** configured to receive the distal end **276** of control rod **52** (See FIG. **35**) when the proximal end of disposable loading unit **16** is engaged with elongated body **14** of surgical stapling apparatus **10**.

The distal end of drive beam **266** is defined by a vertical support strut **278** which supports a knife blade **280**, and an abutment surface **283** which engages the central portion of actuation sled **234** during a stapling procedure. Surface **285** at the base of surface **283** is configured to receive a support member **287** slidably positioned along the bottom of the staple cartridge **220**. Knife blade **280** is positioned to translate slightly behind actuation sled **234** through a central longitudinal slot **282** in staple cartridge **220** (FIG. **30**) to form an incision between rows of stapled body tissue. A retention flange **284** projects distally from vertical strut **278** and supports a cylindrical cam roller **286** at its distal end. Cam roller **286** is dimensioned and configured to engage cam surface **209** on anvil body **204** to clamp anvil portion **204** against body tissue.

Referring also to FIGS. **36-39**, a locking device **288** is pivotally secured to drive member **270** about a pivot pin **290**. Locking device **288** includes a pair of elongate glides **292** and **294** which define a channel **296**. A web **298** joins a portion of the upper surfaces of glides **292** and **294**, and is configured and dimensioned to fit within elongated slot **298** formed in drive beam **266** at a position distal of drive member **270**. Horizontal cams **300** and **302** extend from glides **292** and **294** respectively, and are accommodated along an inner surface of lower housing half **252**. As best shown in FIG. **42**, a torsion spring **304** is positioned adjacent drive member **270** and engages horizontal cams **300** and **302** of locking device **288** to normally bias locking device **288** downward toward lower housing half **252** onto ledge **310**. Locking device **288** translates through housing portion **200** with axial drive assembly **212**. Operation of locking device **288** will be described below.

Sequence of Operation

Referring to FIGS. **40-44**, to use stapling instrument **10**, a disposable loading unit **16** is first secured to the distal end of elongated body **14**. As discussed above, stapling instrument **10** can be used with articulating and non-articulating disposable loading units having linear rows of staples between about 30 mm and about 60 mm. To secure disposable loading unit **16** to elongated body **14**, the distal end **276** of control rod **52** is inserted into insertion tip **193** of disposable loading unit **16**, and insertion tip **193** is slid longitudinally into the distal end of elongated body **14** in the direction indicated by arrow "A" in FIG. **41** such that hook portion **258** of second articulation link **256** slides within a channel **310** in elongated body **314**. Nubs **254** will each be aligned in a respective channel (not shown) in elongated body **14**. When hook portion **258** engages the proximal wall **312** of channel **310**, disposable loading unit **16** is rotated in the direction indicated by arrow "B" in FIGS. **41-44** to move hook portion **258** of second articulation link **256** into engagement with finger **164** of first articulation link **123**. Nubs **254** also forms a bayonet type coupling within annular channel **314** in body **14**. During rotation of loading unit **16**, nubs **254** engage cam surface **195** (FIG. **41**) of block plate **192** to initially move plate **192** in the direction indicated by arrow "C" in FIGS. **41** and **43** to lock engagement member **196** in recess **199** of control rod **52** to prevent longitudinal movement of control rod **52** during attachment of disposable loading unit **16**. During the final degree of rotation, nubs **254** disengage from cam surface **195** to allow blocking plate **192** to move in the direction indicated by arrow "D" in FIGS. **42** and **44** from behind engagement member **196** to once again permit longitudinal movement of control rod **52**.

Referring to FIGS. **43** and **43***a*, when insertion tip **193** engages the distal end of sensor tube **176**, the disposable loading unit sensing mechanism is actuated. Insertion tip **193** engages and moves sensor tube **176** proximally in the direction indicated by arrow "E" in FIG. **43**. As discussed above, proximal movement of sensor tube **176** effects proximal movement of sensor cylinder **178** and sensor link **182** in the direction indicated by arrow "E" in FIG. **43***a* to pivot locking member **83** counter-clockwise, as indicated by arrow "Y" in FIG. **43***a*, from a non-blocking position to a position blocking movement of actuation shaft **46**.

Referring to FIGS. **46-49**, with a disposable loading unit attached to stapling instrument **10**, tool assembly **17** can be positioned about tissue **320** (FIG. **45**). To clamp tissue between anvil assembly **20** and cartridge assembly **18**, stationary handle **24** is moved in the direction indicated by arrow "E" in FIG. **46** against the bias of torsion spring **40** to move driving pawl **42** into engagement with shoulder **322** on actuation shaft **46**. Engagement between shoulder **322** and driving pawl **42** advances actuation shaft **46** and thus advances control rod **52** distally. Control rod **52** is connected at its distal end to axial drive assembly **212** (FIG. **48**), including drive beam **266**, such that distal movement of control rod **52** effects distal movement of drive beam **266** in the direction indicated by arrow "F" in FIGS. **48** and **49**, moving cam roller **286** into engagement with cam surface **209** on anvil portion **204** to urge anvil portion **204** in the direction indicated by arrow "G" in FIG. **49**. It is noted that one complete stroke of movable handle **24** advances actuation shaft **46** approximately 15 mm which is sufficient to clamp tissue during the first stroke but not to fire staples.

As discussed above with respect to the anti-reverse clutch mechanism, during the first (clamping) stroke of movable handle **24**, slide plate **102** (FIG. **46**) prevents locking pawl **54** from engaging toothed rack **48**. To maintain actuation shaft **46** in its longitudinal position after handle **24** is released, an engagement member **324** (FIG. **47**) is provided on locking member **83** to engage shoulder **326** on actuation shaft **46** and retain shaft **46** in its longitudinal position (See FIG. **47**). Upon release of movable handle **24**, drive pawl **42** moves over rack **48** as torsion spring **40** returns handle **24** to a position spaced from stationary handle **22**. In this position, driving pawl **42** is urged into engagement with toothed rack **48** to retain actuation shaft **46** in its longitudinal fixed position.

In order to fire staples, movable handle **24** is actuated again, i.e., moved through another stroke. As discussed above, stapling apparatus **10** is capable of receiving disposable loading units having linear rows of staples of between about 30 mm and about 60 mm. Since each stroke of the movable handle **24** preferably advances actuation shaft **46** 15 mm, and one stroke is required to clamp tissue, the movable handle must be actuated (n+1) strokes to fire staples, where n is the length of the linear rows of staples in the disposable loading unit attached to stapling instrument **10** divided by 15 mm.

Referring to FIG. **50**, prior to being able to fire staples, firing lockout assembly **80** (FIG. **4**) must be actuated to move locking surface **88** from its blocking position (FIG. **47**) to a non-blocking position. This is accomplished by pressing down on plunger **82** to move camming surface **85** into engagement with sidewalls of slot **89** of locking member **83** to pivot locking member **83** in the direction indicated by arrow

"G" in FIG. **50** (see also FIG. **5**). Thereafter, movable handle **24** may be actuated an appropriate number of strokes to advance actuation shaft **46**, and thus control rod **52** and drive beam **266**, distally in the direction indicated by arrow "H" in FIGS. **51** and **52** to advance actuation sled **234** through staple cartridge **220** to effect ejection of staples. It is noted that after the first or clamping stroke of movable handle **54** (during the second stroke), slide **102** passes over locking pawl **54** allowing torsion spring **56** to move locking pawl **54** in the direction indicated by arrow "I" in FIG. **50** into engagement with toothed rack **48** to retain actuation shaft **46** in its longitudinal position.

Referring to FIG. **53**, to retract actuation shaft **46** and thus control rod **52** and drive member **266** after firing staples, retraction knobs **32** (see FIG. **1**) are pulled proximally causing pins **66** to move release plate **64** in the direction indicated by arrow "J" in FIG. **53** over teeth **48** to disengage drive pawl **42** from engagement with teeth **48**. As discussed above, with respect to the anti-reverse clutch mechanism, locking pawl **54** is urged by slide plate **102** out of engagement with toothed rack **48** (not shown) to permit actuation shaft **46** to be moved proximally, in the direction indicated by arrow "L", after drive pawl **42** is disengaged from teeth **48**.

Referring to FIG. **54**, in order to retract actuation shaft **46** prior to firing stapling apparatus, i.e., when locking pawl is currently engaged with toothed racked **48**, emergency return button **112** is pushed in the direction indicated by arrow "Z" in FIG. **54** to disengage locking pawl **54** from toothed rack **48**. Retraction knobs **32** (FIG. **1**) must also be concurrently pulled rearwardly, as discussed above, to release drive pawl **42** from rack **48**.

Referring to FIGS. **55-61**, when an articulating disposable loading unit is secured to elongated body **14** and articulation lever **30** is pivoted in the direction indicated by arrow "M" in FIG. **55**, cam member **136** is moved transversely by projection **142** (FIG. **10**) in the direction indicated by arrow "N" between flanges **170** and **172** of rotation knob **28**. Since translation member **138** is prevented from rotating by ridges **156** (FIG. **13**), pin **166**, which is fixedly secured to translation member **138**, is forced to move along stepped cam surface **148**. Movement of pin **166** causes corresponding movement of translation member **138** in the direction indicated by arrow "P" in FIGS. **55** and **56** to advance first articulation link **123** in the distal direction. The distal end of first articulation link **123** engages the proximal end of second articulation link **256** (FIG. **42**) which is connected to projection **262** on mounting assembly **202** to advance second link **256** in the direction indicated by arrow "Q" in FIG. **57**. Projection **262** is laterally offset from pivot members **244**, such that distal advancement of second articulation link **256** causes mounting assembly **202** and thus tool assembly **17** to pivot in the direction indicated by arrow "R" in FIGS. **57** and **58**. Note in FIG. **59** that rotation member **28** can be rotated to rotate elongated body **14** about its longitudinal axis while tool assembly **17** is articulated.

FIGS. **60-61** illustrate articulation of tool assembly **17** in the opposite direction to that described above. When second articulation link **256** is retracted by rotating articulation lever **30** in a counter-clockwise direction (not shown) as viewed in FIG. **55**, pin **66** is forced to move proximally along stepped camming surface **148**, moving translation member **138** and first articulation link **123** proximally. Movement of first articulation link **123** proximally, causes second articulation link **256** to move proximally as indicated by arrow "S" in FIG. **58**, to rotate tool assembly **17** in a clockwise direction, as indicated by arrow "T" in FIG. **61**.

Referring to FIG. **12**, movement of pin **166** (FIG. **9**) between adjacent step portions **340** causes tool assembly **17** to articulate 22.5 degrees. Camming surface **148** includes five step portions **340**. The third step portion corresponds to the non-articulated tool assembly position, whereas the first and the fifth step portions correspond to articulation of tool assembly **17** to forty-five degrees. Each step portion is flat to retain articulation lever **30** in a fixed position when pin **166** is engaged therewith.

Referring now to FIGS. **37**, **39**, **62** and **63**, the sequence of lockout operation will be described in detail. In FIG. **39**, lockout device **288** is shown in its prefixed position with horizontal cams **300** and **302** resting on top of projections **330** formed in the sidewalls of lower housing half **252** (FIG. **37**). In this position, locking device **288** is held up out of alignment with projection **332** formed in the bottom surface of lower housing half **252**, and web **298** is in longitudinal juxtaposition with shelf **334** defined in drive beam **266**. This configuration permits the anvil **20** (FIG. **38**) to be opened and repositioned onto the tissue to be stapled until the surgeon is satisfied with the position without activating locking device **288** to disable the disposable loading unit **16**.

As shown in FIG. **62**, upon distal movement of drive beam **266**, locking device **288** rides off of projections **330** (not shown) and is biased into engagement with base lower housing half **252** by spring **304**, distal to projection **332**. Locking device **288** remains in this configuration throughout firing of the apparatus.

Upon retraction of the drive beam **266** in the direction indicated by arrow "U" in FIG. **62**, locking device **288** passes under projections **330** and rides over projection **332** until the distalmost portion of locking device **288** is proximal to projection **332**. Spring **304** biases locking device **288** into juxtaposed alignment with projection **332**, effectively disabling the disposable loading unit. If an attempt is made to reactuate the apparatus, the control rod **52** will abut a proximal end surface of locking device **288** which surface is diagonally sloped to impart a moment about pivot pin **342** such that the distal end of locking device **288** is rotationally urged into contact with projection **332**. Continued distal force in the direction indicated by arrow "W" in FIG. **63**, will only serve to increase the moment applied to the locking device thus the locking device will abut projection **332** and inhibit distal movement of the control rod **52**.

Referring again to FIGS. **41-44**, the disabled or locked disposable loading unit can be removed from the distal end of elongated body **14** by rotating disposable loading unit **16** in the direction opposite to the direction indicated by arrow "B" in FIGS. **41**, **42** and **44**, to disengage hook portion **258** of second articulation link **256** from finger **164** of first articulation link **123**, and to disengage nubs **254** from within channel **314** of elongated body **14**. After rotation, disposable loading unit **16** can be slid in the direction opposite to that indicated by arrow "A" in FIG. **41** to detach body **14** from disposable loading unit **16**. Subsequently, additional articulating and/or non-articulating disposable loading units can be secured to the distal end of elongated body, as described above, to perform additional surgical stapling and/or cutting procedures. As discussed above, each disposable loading unit may include linear rows of staples which vary from about 30 mm to about 60 mm.

It will be understood that various modifications may be made to the embodiments disclosed herein. For example, the stapling apparatus need not apply staples but rather may apply two part fasteners as is known in the art. Further, the length of the linear row of staples or fasteners may be modified to meet the requirements of a particular surgical procedure. Thus, the length of a single stroke of the actuation shaft and/or the length of the linear row of staples and/or fasteners within a disposable loading unit may be varied accordingly. Therefore, the above description should not be construed as limiting, but merely as exemplifications of preferred embodiments. Those skilled in the art will envision other modifications within the scope and spirit of the claims appended thereto.

While the invention has been illustrated and described as embodied in an apparatus and method for performing surgical tasks, it is not intended to be limited to the details shown, since it will be understood that various omissions, modifications, substitutions and changes in the forms and details of the device illustrated and its operation can be made by those skilled in the art without departing in any way from the spirit or scope of the appended claims.

What is claimed is:

1. A method of performing a surgical procedure comprising:

inserting a disposable loading unit into a distal end of an elongate body;

causing the disposable loading unit to engage a sensing mechanism supported within the elongate body;

displacing a portion of the sensing mechanism to permit movement of a locking member from a first position, wherein the locking member is positioned to permit firing of the disposable loading unit, to a second position, wherein the locking member is positioned to inhibit firing of the disposable loading unit;

manipulating a lockout assembly to permit the locking member to return to the first position, and thereby permit firing of the disposable loading unit; and

firing the disposable loading unit to apply one or more surgical fasteners to tissue.

2. The method of claim **1**, wherein displacing the portion of the sensing mechanism includes overcoming a bias applied to the locking member by a biasing member.

3. The method of claim **1**, wherein displacing the portion of the sensing mechanism includes sliding the portion of the sensing mechanism within the elongate body.

4. The method of claim **3**, wherein displacing the portion of the sensing mechanism includes sliding a sensor tube within the elongate body.

5. The method of claim **4**, wherein causing the disposable loading unit to engage the sensing mechanism includes causing the disposable loading unit to engage a distal end of the sensor tube.

6. The method of claim **4**, wherein sliding the sensor tube within the elongate body includes sliding the sensor tube in a proximal direction away from an end effector of the disposable loading unit.

7. The method of claim **6**, wherein sliding the sensor tube within the elongate body includes causing a sensor cylinder and a sensor link to move in the proximal direction away from the end effector of the disposable loading unit.

8. The method of claim **7**, wherein moving the sensor link in the proximal direction includes causing an end of the sensor link to move distally to permit movement of the locking member from the first position to the second position.

9. The method of claim **8**, wherein moving the sensor link in the proximal direction includes causing the end of the sensor link to move distally of a camming surface formed on the locking member.

10. The method of claim **1**, wherein displacing the portion of the sensing mechanism includes moving the locking member into engagement with an actuation shaft.

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